TN NO. 66T-3

UNITED STATES NAVAL POSTGRADUATE SCHOOL

DEPARTMENT OF AERONAUTICS

TECHNICAL NOTE

NO. 66T 3

AN INVESTIGATION OF THE FLOW CONDITIONS AT THE LOWER MEASURING PLANE, AND IN THE PLENUM CHAMBER OF THE RECTILINEAR CASCADE TEST FACILITY

by

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PROPULSION LABORATORIES
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APRIL 1966

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SUMMARY

This report describes the tests made to determine the flow conditions that exist ahead of the cascade and establishes a basis for future modification of the cascade test facility. The investigation was conducted with an existing adverse pressure gradient between the lower and upper measuring plane, Dead water regions were evident near the side walls of the test section, and large velocity differences were found to exist in the plenum. The investigation indicated that the boundary layer removal system, the provisions for which already exist, should be utilized for cascade tests involving adverse pressure gradients.

INTRODUCTION

During the summer of 1965, cascade tests were conducted on compressor blade profiles at the cascade test facility of the U. S. Naval Postgraduate School. These were the first such tests utilizing axial compressor type blading.

Results of these tests indicated large turbulence areas in the vicinity of the test section side walls aft of the blade models, and irregularities in the flow approaching the test blades.

In order to minimize the effect of irregularities in the flow ahead of the cascade test blade row, studies of the flow characteristics in the vicinity of the lower measuring plane and of the flow in the plenum chamber were conducted.

Total pressure surveys across the width of the test section were made at various stations along the lower measuring plane. The velocity pattern of the flow in the plenum chamber below the test section entrance (the bellmouth) was physically observed in an attempt to correlate plenum conditions with test section conditions.

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DESCRIPTION OF APPARATUS

A description of the Rectilinear Cascade Test Facility is found in Reference (1).

Total pressure surveys were obtained by using a pitot probe which was inserted into the test section through the receptacle in the traverse carriage that is normally occupied by the United Sensor YC - 120 probes. The U. S. YC - 120 probes were not used because of large insertion (wall-probe interference) errors close to the wall. A hook type pitot probe was used to minimize flow perturbations due to instrumentation. Also, with a hook type probe it is possible to measure close to the side wall and ahead of disturbances caused by the lower traverse slit. The pitot probe was retained by a United Sensor probe holder which was mounted on the frame of the lower traverse carriage. The distance into the test section at which the probe head was located was read from a graduated scale on the probe holder. This scale could be read to within 0.01 inches. Rough readings of yaw angle (Θ) were also indicated. The total pressure was read from a 70" water manometer with an accuracy of $\pm$ 0.1 in. H_2O.

In order to observe the flow pattern in the plenum, tufts of wool were placed at different spacings throughout the plenum chamber. These tufts were placed around the entrance to the bell-mouth, along the north and south wall and on a metal framework of approximate dimentions 9' x 12' x 12' which was situated in the center of the plenum. The plenum was entered by the observer and closed. The blower was then run at low speed, with its inlet guide vanes open. Communications between blower operator and the observer inside the

plenum was accomplished by battery powered U. S. Army type field phones. Velocity patterns were further observed throughout the volume of the plenum by fixing a wool tuft to the end of a long pole with which the observer could reach the extremities of the plenum.

The models that were installed at the time these tests were conducted axial compressor blades of the C-4 type with a rounded trailing edge. The cascade had a solidity of 1.29 and a stagger angle of 62°.

PROCEDURE

Total pressure surveys were made at a plenum pressure of 36.8 in. of H_2O. The stations along the lower traverse at which the surveys were made are indicated in Fig. (1). Total pressure readings beyond Y = 9 in. were not possible due to the physical limit to which the probe could be moved into the test section.

Flow observations in the plenum were made at a plenum pressure of 10.4 in. of H_2O. During the first test, photographs of the tuft patterns were taken by Professor L. T. Clark. Hand sketches of the tuft patterns were also made.

RESULTS AND DISCUSSION

Plots of total pressure (PTL), dynamic pressure (DPL) and static pressure (PSL) versus distance along the lower measuring plane (x) are given in Figs. 2, 3, and 4. These data are the results of cascade test #201 (C-4 compressor blades). The data was taken with the normal traversing equipment described in reference 1, with the probe traversing

the center of the test section (Y = 5.0 in). The wake patterns of the test section entrance guide vanes are clearly evident in Fig. 2.

Plots of total pressure (P_t) versus distance into the test section (Y) at the various stations are given in Fig. (5). In each case, fluctuations in P_t were large near the wall (y = 0 in. to y = 1.5 in.). These fluctuations were of the order $\pm$ 1.0 in. of H_2O. Readings steadied out toward the center of the test section. The probe head was rotated in yaw until the highest total pressure was found. This value of P_t was recorded as well as the indicated value of Θ (deg.). Since the type of probe used cannot accurately sense direction of flow, the readings of Θ on the data sheets (Appendix A) merely indicate trends in the change of flow angle.

These surveys indicated large boundary layer growth from the bell-mouth (entrance) to the lower measuring plane. The total pressure traces from Y - 1.5 in. to Y = 8.5 were moderately uniform. Highest total pressures seemed to occur more toward the north wall of the test section (in the vicinity of Y = 8.0 in.).

The test section static pressure taps described in reference (1) were utilized and the static pressure distribution is shown in Fig. (6).

Observations of the flow in the plenum revealed that the flow was not coming straight out of the sound baffle grid. It was, instead, canted toward the north wall.

In addition, flow entered the plenum only through the center portion of the sound baffle grid. No flow was observed to be coming through the baffles located near the walls, overhead or floor. From the view of an observer standing in the middle of the plenum, facing

the north wall, the flow traveled clockwise around the plenum on its way up to the bell-mouth. Wool tufts located at the east end of the bell-mouth entrance were oriented in a southerly direction instead of pointing in toward the center of the bell-mouth entrance (west). Sketches and photographs of tuft orientation are given in Figs. 7 through 12.

The vortex motion of the flow in the plenum and especially the poor velocity distribution toward the east end of the bell-mouth entrance seemed to warrant some corrective steps to force the plenum flow into a more favorable velocity approach to the bell-mouth. Consequently, a set of turning vanes was constructed in the plenum chamber. Its purpose was to deflect the flow toward the bell-mouth and "break-up" the vortex pattern of the flow. A description of the turning vanes is shown in Fig. (13). Fig. (14) shows the lower level of the cascade test facility.

After the turning vanes were installed, total pressure traverses were repeated at stations 5 to 10. (Run #205). Very little change in the distribution of P_t was noted. However, fluctuations in total pressure close to the wall were of smaller magnitude, i.e., the flow appeared to be more steady. Observations of plenum flow were again made, and a definite improvement in plenum conditions was noted. Tufts in the vicinity of the bell-mouth. However, the flow was still not coming out normal to the plane of the sound baffle grid. Most of the flow was being deflected by the north half of the turning vane arrangement. Plywood baffles were then situated as also shown in Fig. (13). These baffles blocked the flow along the north wall and caused the flow

to straighten. Although the turning vanes did succeed in deflecting the flow up toward the bell-mouth, it was noted the velocities were higher toward the west end of the bell-mouth entranc.

After installation of the baffles, another total pressure traverse was made at Station 4. Virtually the same conditions continued to prevail.

The variations in dynamic pressure at the lower measuring plane due to the test section entrance guide vanes is not necessarily an undesirable condition so long as the wake pattern is uniform. The effect of boundary layer growth through the test section is to reduce the effective flow area. This causes an increase in velocity and a corresponding drop in the local static pressure. The effective flow area is further reduced if the flow separates from the walls in the vicinity of the blade models. The drop in static pressure aft of the test blading due to the decrease in the effective flow area causes an added drag force to be imposed on the models. Pope, in reference (2), calls this added drag force "horizontal buoyancy" in standard aerodynamic wind tunnels. He further suggests that most test sections of wind tunnels are designed so that the walls of the test section diverge slightly in the direction of flow. The test section flow area is thereby increased enough to cancel the effect of decreased area caused by boundary layer growth. Now, if the end walls of the cascade test section were positioned so that they diverge slightly rather than remain parallel, the effect of decreased flow area due to boundary layer growth would in part, be nullified. Since test section configurations vary, no set degree of end wall divergence can be specified. It is suggested,

however, that some tests be conducted to find out if flow improvement can be realized by adjustment of the end wall position.

The need for flow guidance after the test blades is quentionable. First, it is suggested that the presence of the end walls aft of the test cascade presents a blockage to the flow in addition to that caused by the cascade itself. It is further suggested that the flow is influenced to turn not only by the geometry of the cascade under investigation, but also by the end walls and that the end walls aft of the cascade should therefore not be used.

If it were possible to locate the test cascade closer to the test section entrance, the effect of boundary layer growth would be diminished. Also, were the upper traverse located such that the flow was measured just aft of the trailing edge of the cascade, then momentum losses due to wall boundary layer growth would not be detected and would therefore not be charged to the cascade under investigation.

CONCLUSIONS

1. Non-uniform velocity distributions at the lower measuring plane are caused primarily by the wakes of the entrance guide vanes.

2. Velocity gradients in the plenum chamber contribute largely to the relative unsteadiness of the flow in the test section.

3. The installation of the turning vanes did improve the air flow path in the plenum and did aid in reducing time varient fluctuations in the test section.

4. The primary cause for the existence of velocity gradients in the plenum chamber are the so-called sound attentuation baffles.

5. The sound attenuation baffles serve no useful purpose, and in fact, detract from the performance of the cascade test facility.

RECOMMENDATIONS

1. The removal of the sound attentuation panels is strongly recommended.

2. A hyperbolic diffusor should be located as indicated roughly in Fig. (14).

3. The provisions for boundary layer removal ahead of the lower measuring plane should be utilized. The installation of porous walls, blower and associated ducting is recommended.

4. Further investigations to determine the effect of slightly diverging end walls (vice parallel positioning), and of removal of the upper half of the end walls are desirable.

5. The placement of the test cascade closer to the inlet guide vanes is recommended. It would be possible to accomplish this by fabricating a new removable side wall with provisions for a blade holder located closer to the inlet guide vanes. By mounting the upper traverse on the removable wall, the upper probe could be positioned close to the trailing edges of the test cascade. The new side wall should be made of one-inch transparent plexiglas. This would also facilitate visual flow studies with the use of a smoke generator.

REFERENCES

Reference 1: Installation and test of a Rectilinear Cascade, Rose, C. C. and Guttornson, D. L. Thesis, U. S. Naval Postgraduate School, Monterey, California, 1964.

Reference 2: Wind-Tunnel Testing, Pope, A., John Wiley and Sons, Inc., New York, 1954.

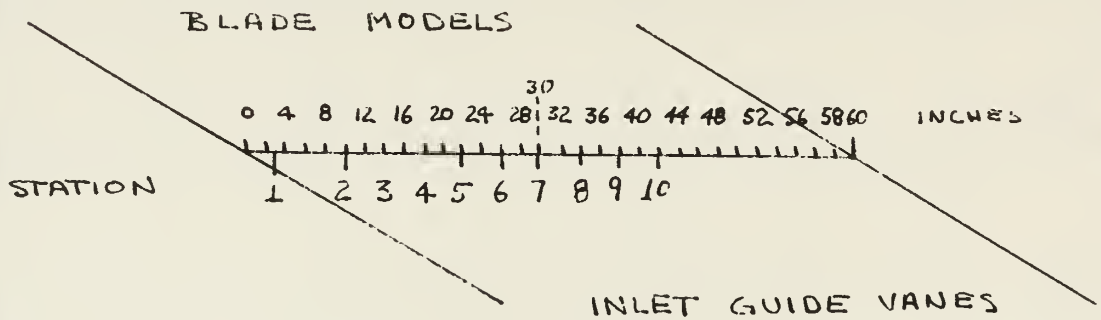


Fig. 1

SCHEMATIC OF RECTILINEAR CASCADE TEST SECTION

STATION NUMBERS INDICATE POSITIONS WHERE TOTAL PRESSURE SURVEYS WERE MADE.

JEB 1-66

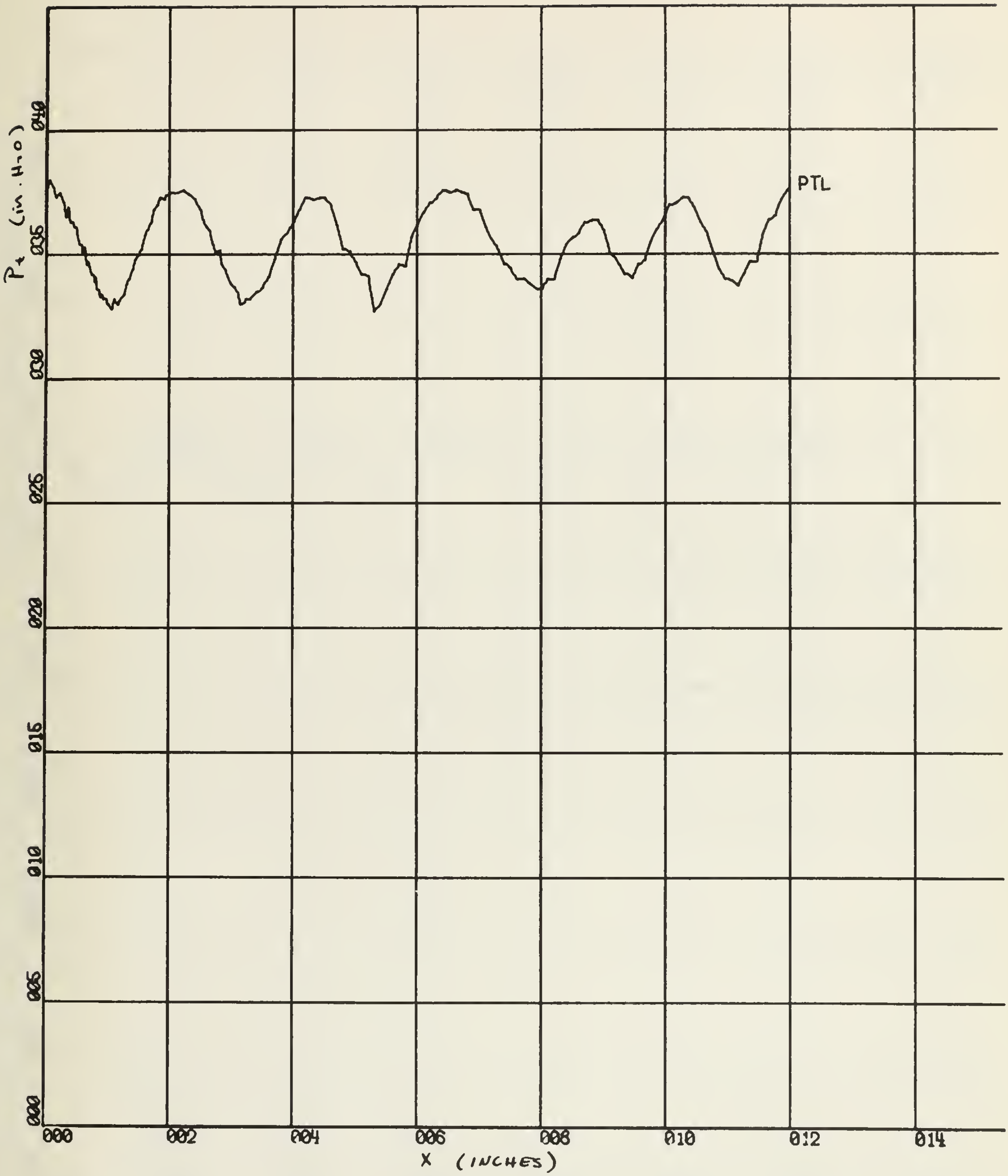


Fig. 2

X-SCALE = 2.00E+00 UNITS/INCH.
Y-SCALE = 5.00E+00 UNITS/INCH.

LOWER TRAVERSE

BARTOCCI RUN 201 CASCADE

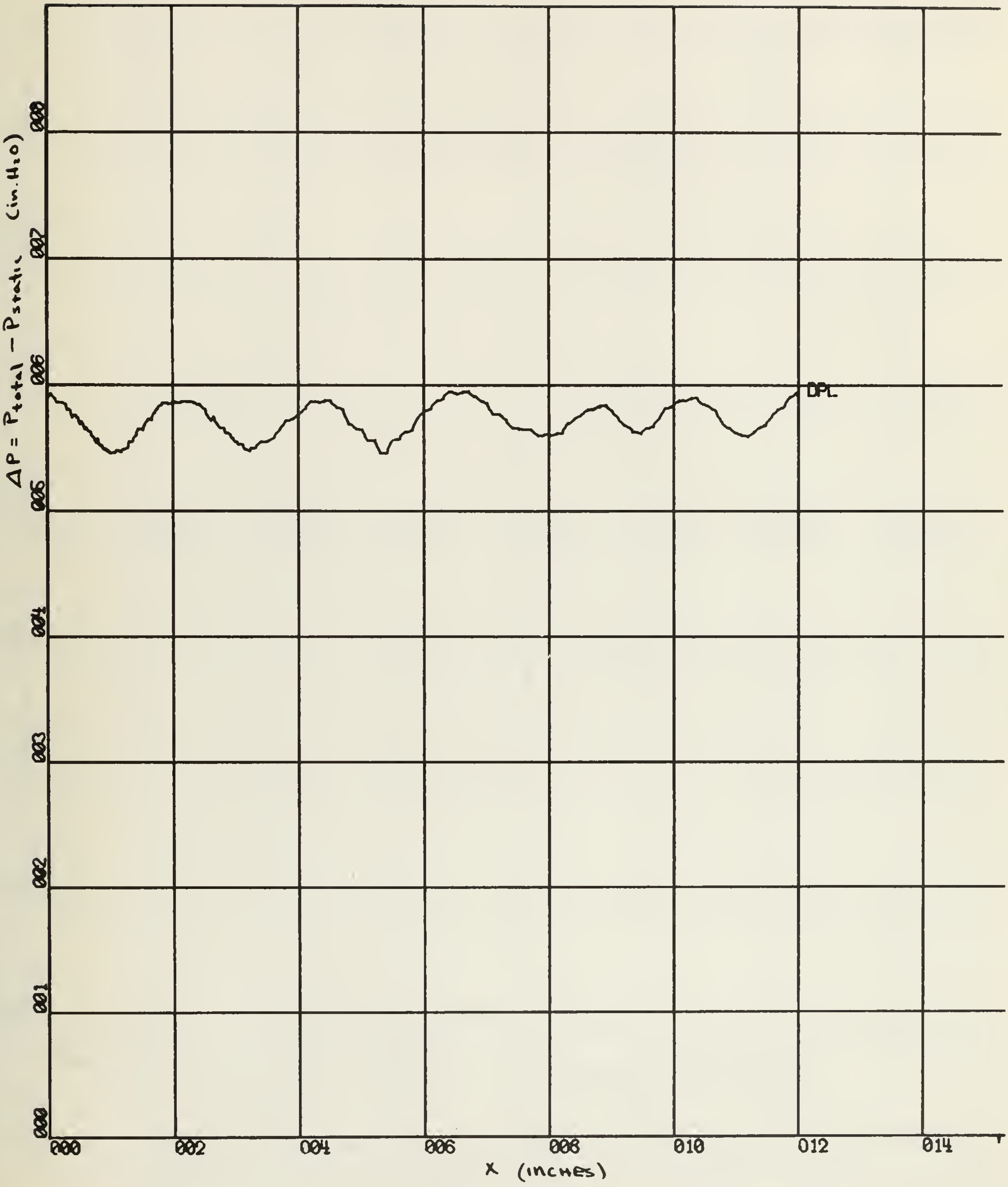


Fig. 3

X-SCALE = 2.00E+00 UNITS/INCH.
Y-SCALE = 1.00E+01 UNITS/INCH.

LOWER TRAVERSE

BARTOCCI RUN 201 CASCADE

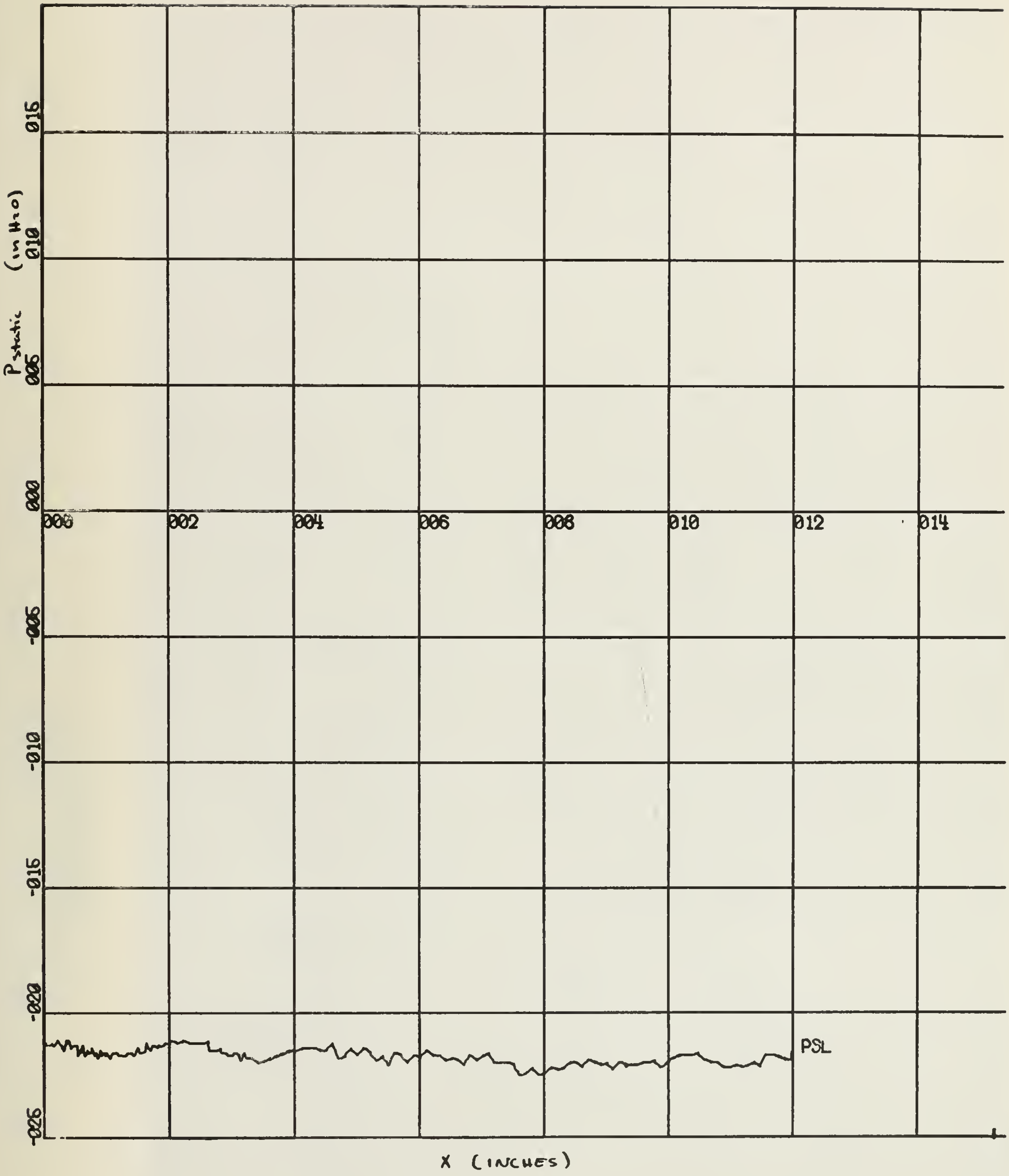
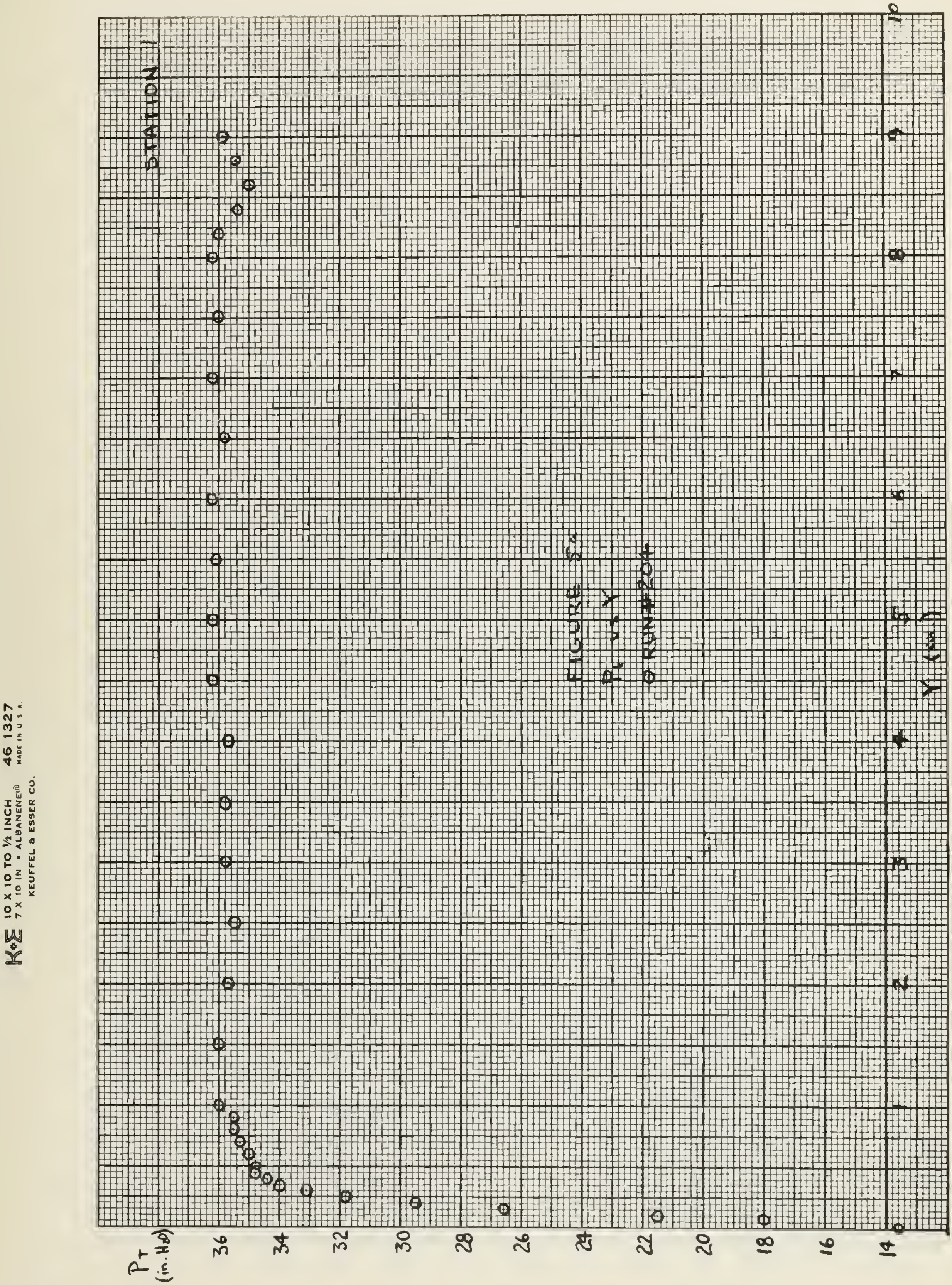


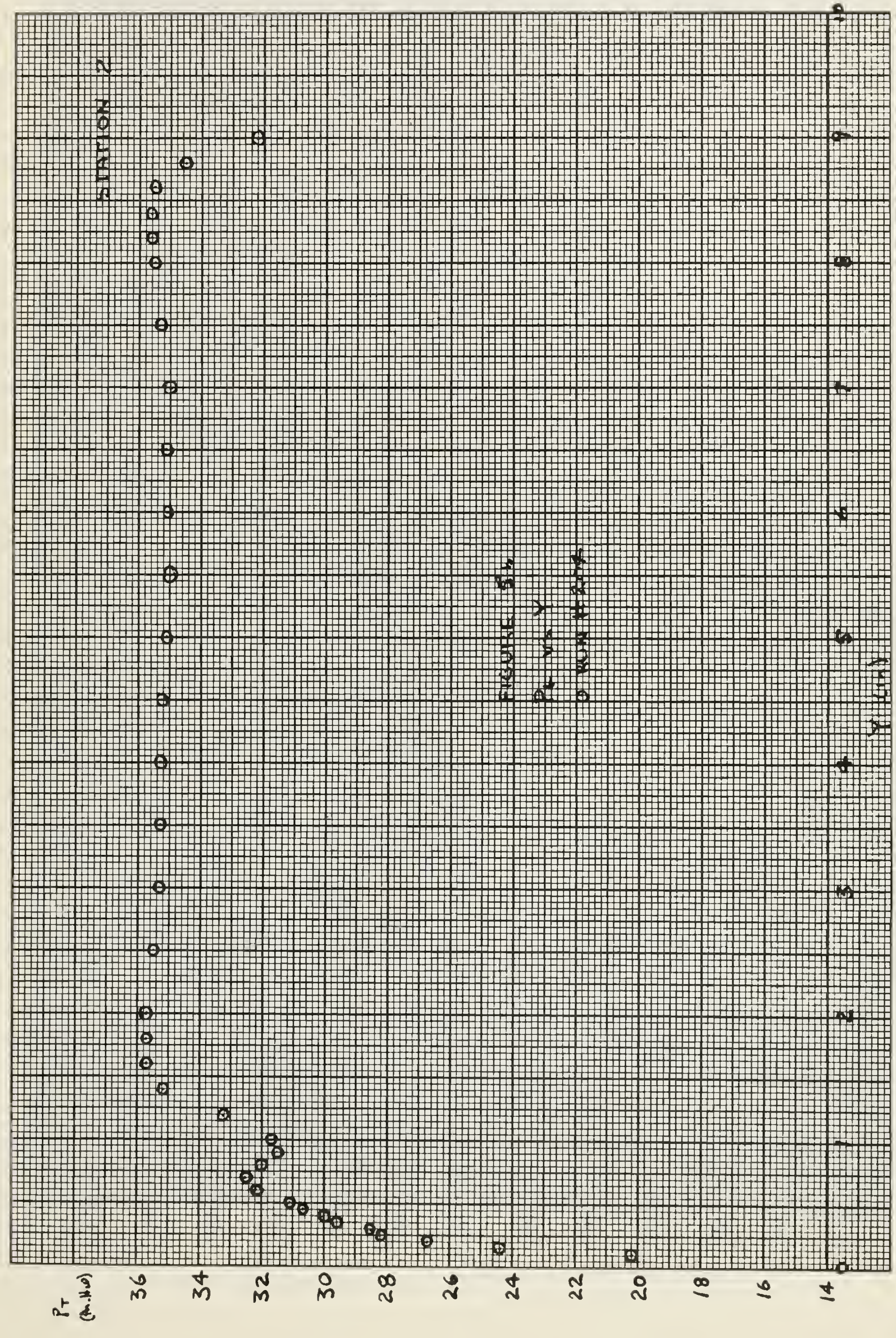
Fig 4.

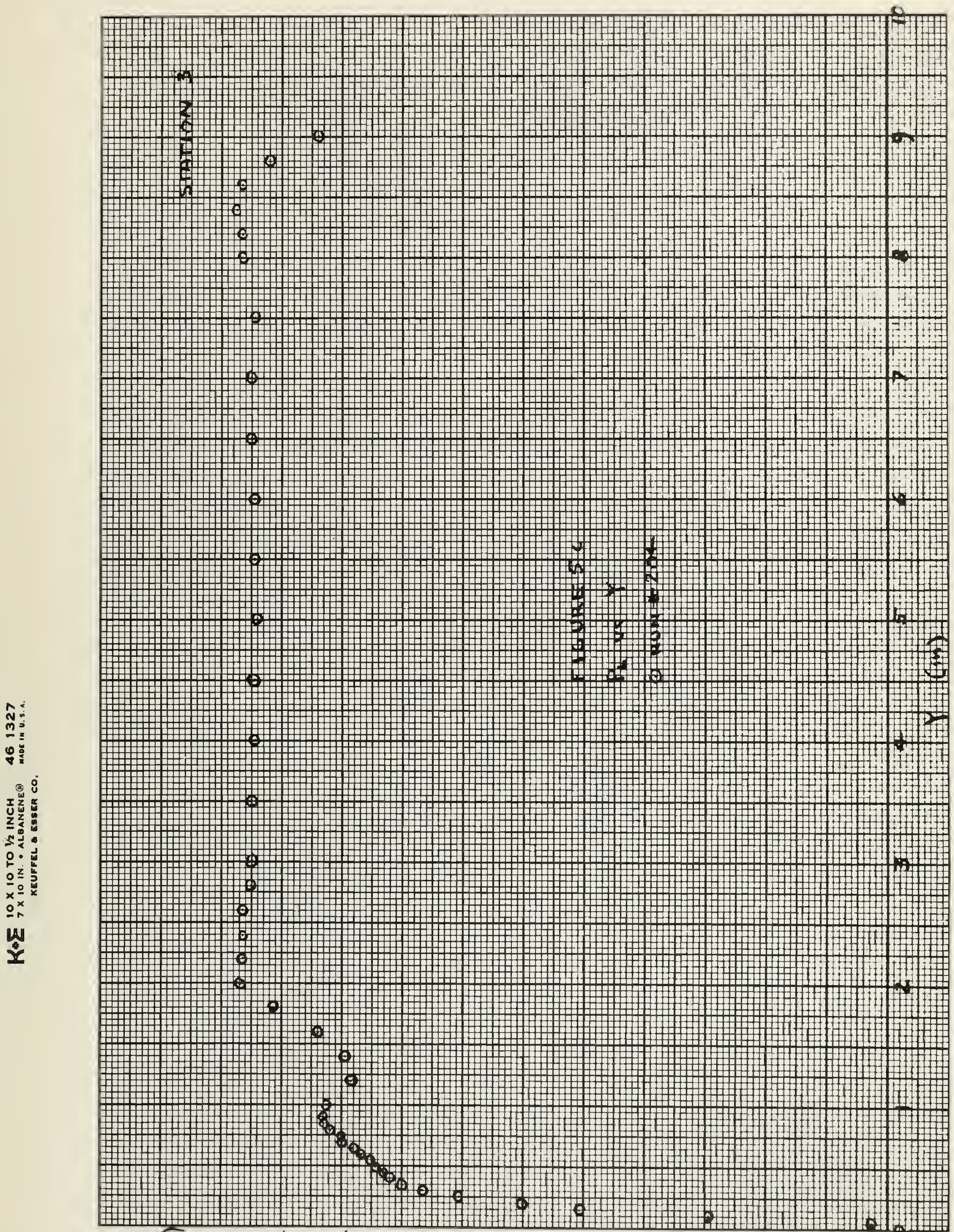
X-SCALE = 2.00E+00 UNITS/INCH.
Y-SCALE = 5.00E+00 UNITS/INCH. Lower Traverse

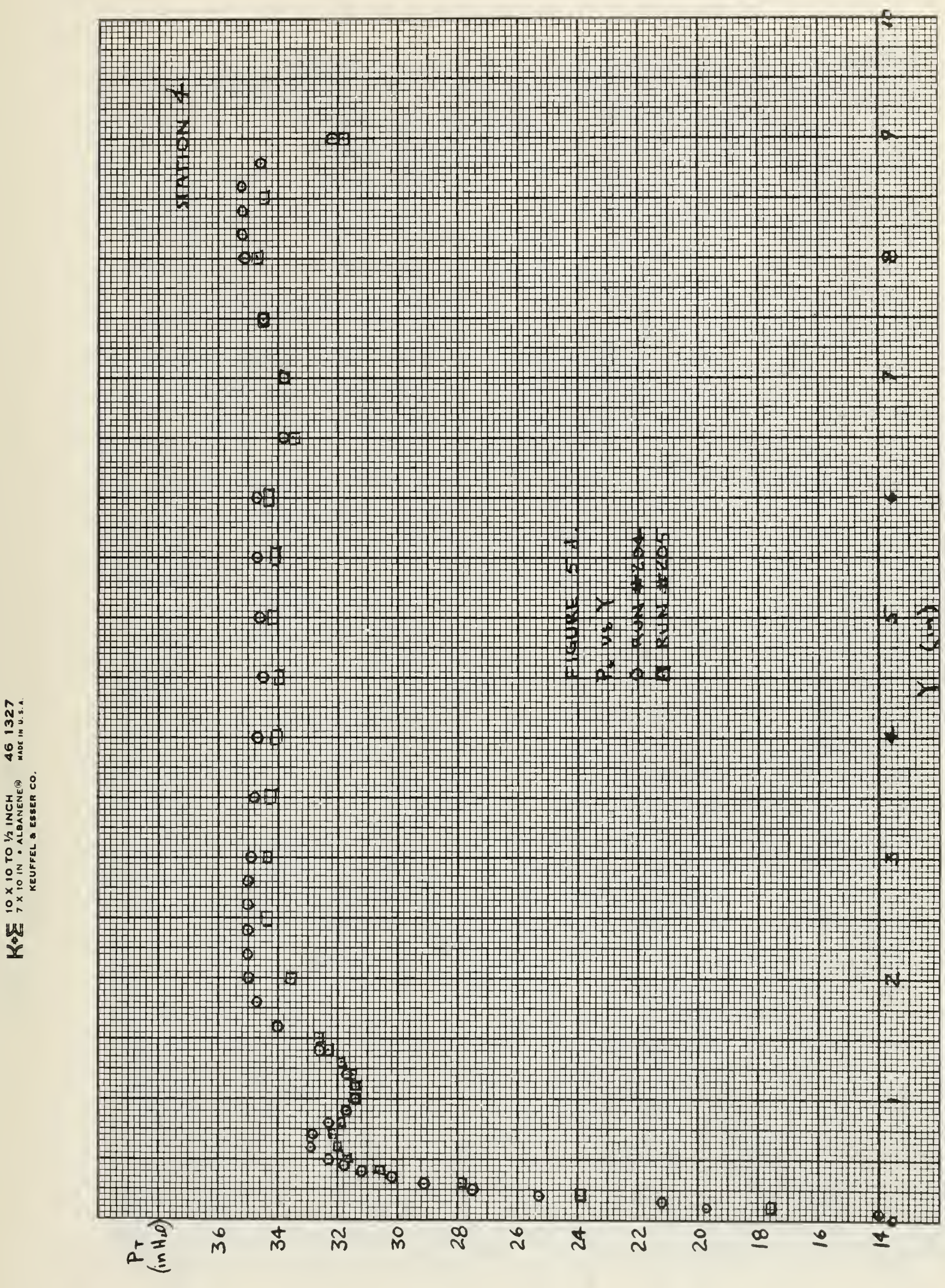
BARTOCCI RUN 201 CASCADE

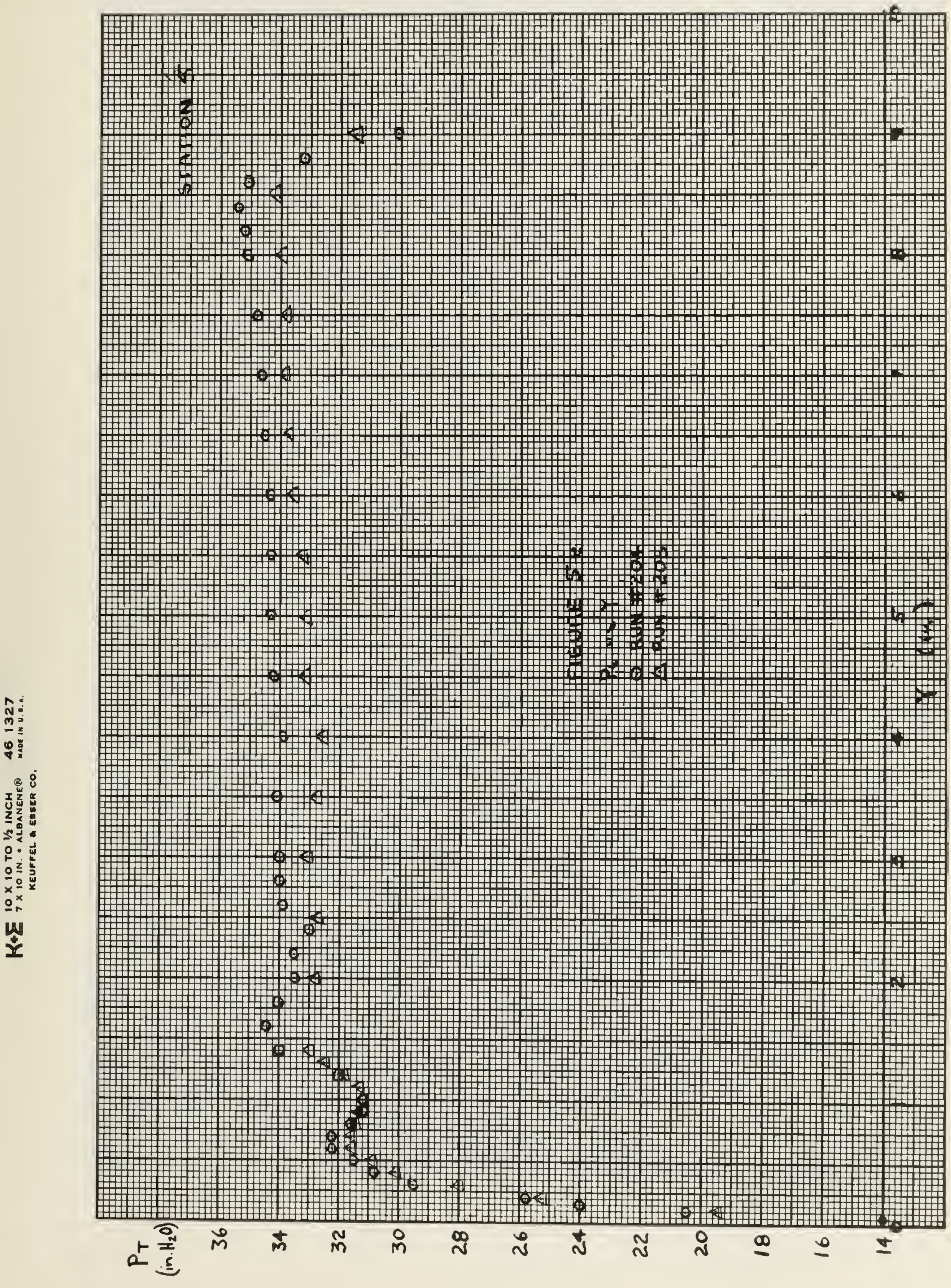


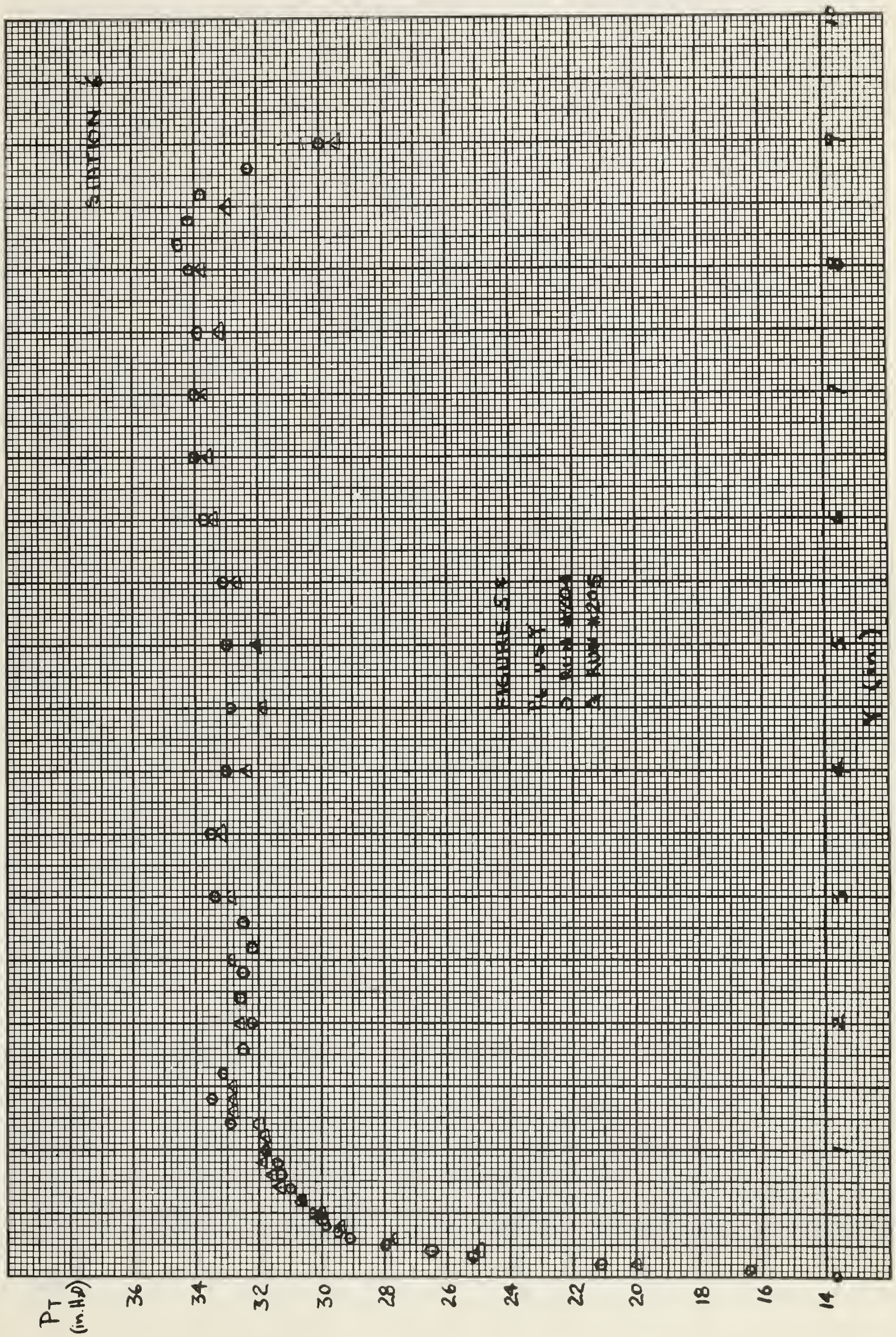
K+E 10 X 10 TO 1/2 INCH 46 1327
7 X 10 IN • ALBANENE MADE IN U.S.A.
KEUFFEL & ESSER CO.
STATION 1
FIGURE 5
P_t vs Y
RUN #204
Y (in.)
P_T (in. H_2O)
36
34
32
30
28
26
24
22
20
18
16
14
1
2
3
4
5
6
7
8
9
10


STATION 2
FIGURE 5b
P_T vs Y
RUN #2-4
P_T (in. H_2O)
36
34
32
30
28
26
24
22
20
18
16
14
Y (in)
1
2
3
4
5
6
7
8
9
10

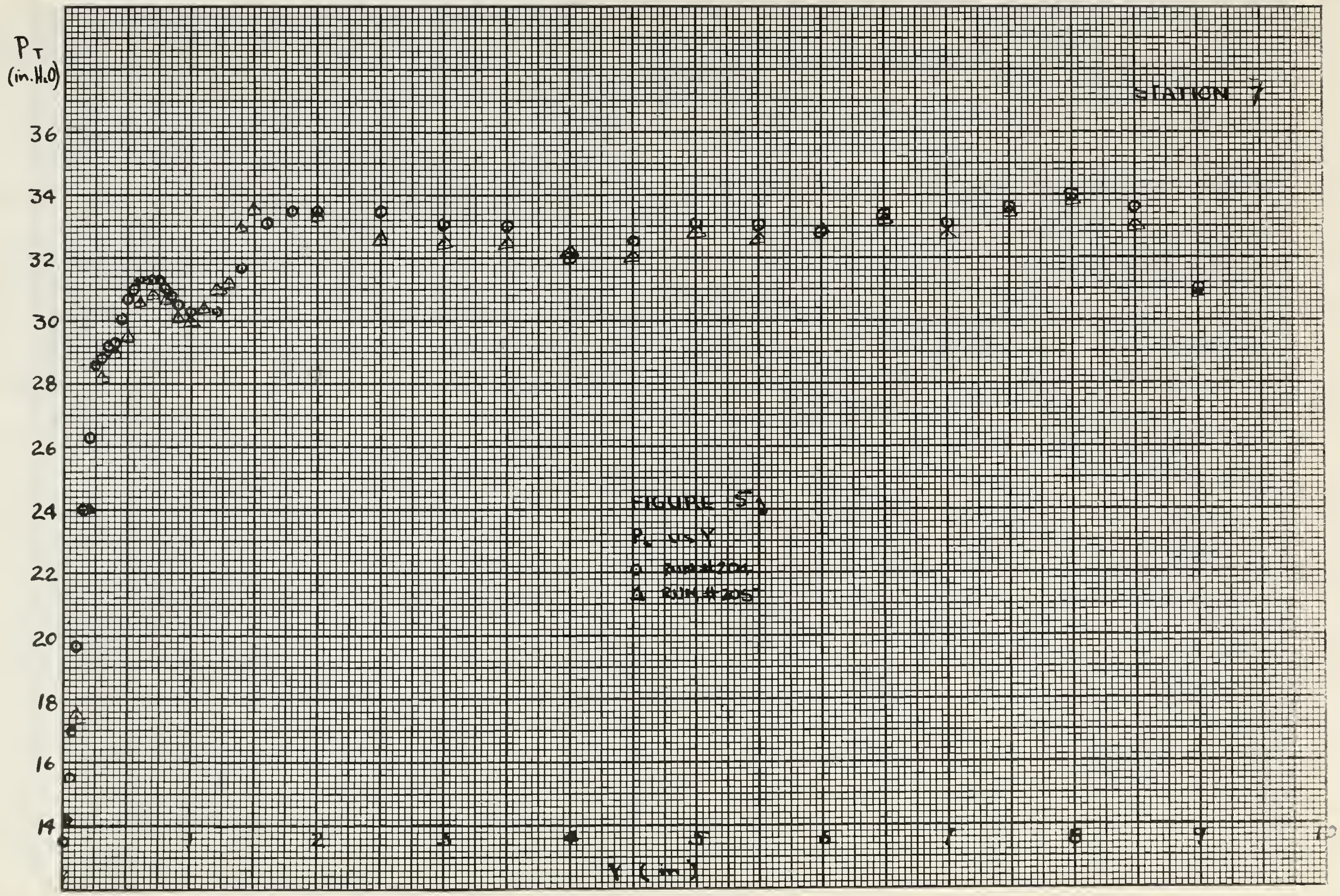

K+E 10 X 10 TO ½ INCH 46 1327
7 X 10 IN. • ALBANENE® MADE IN U.S.A.
KEUFFEL & ESSER CO.
STATION 3
FIGURE 5c
P_T vs Y
P_T (in H₂O)
36
34
32
30
28
26
24
22
20
18
16
14
1
2
3
4
5
6
7
8
9
10
Y (in)


K+E 10 X 10 TO 1/2 INCH 46 1327
7 X 10 IN. • ALBANENE® MADE IN U.S.A.
KEUFFEL & ESSER CO.
STATION 4
FIGURE 5 d.
P_T vs Y
RUN #204
RUN #205
P_T (in H2O)
36
34
32
30
28
26
24
22
20
18
16
14
1
2
3
4
5
6
7
8
9
10
Y (in)

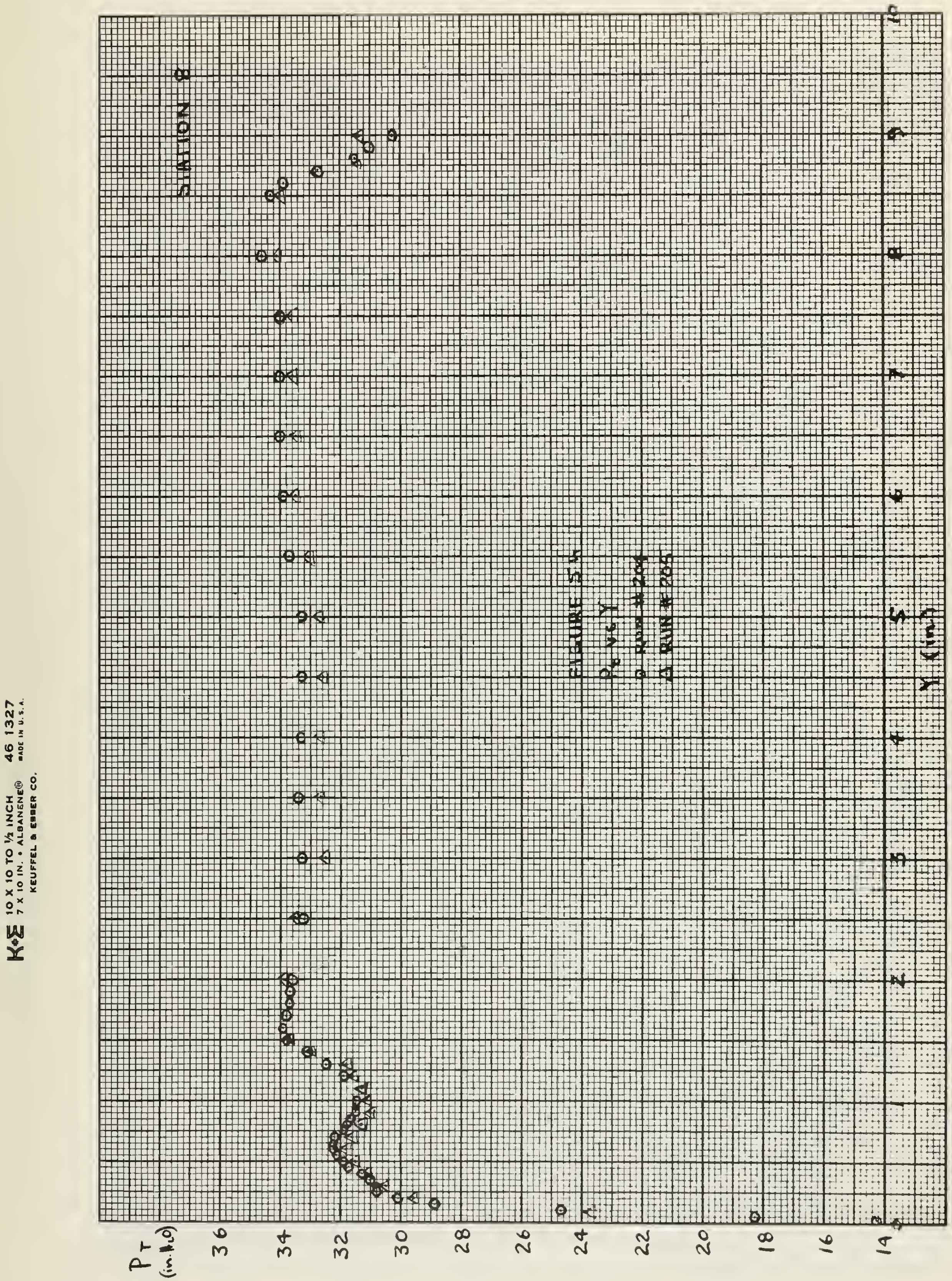

K+E 10 X 10 TO 1/2 INCH 46 1327
7 X 10 IN. • ALBANENE® MADE IN U.S.A.
KEUFFEL & ESSER CO.
STATION 5
FIGURE 5
P_T vs Y
RUN #204
RUN #205
P_T (in. H_2O)
36
34
32
30
28
26
24
22
20
18
16
14
1
2
3
4
5
6
7
8
9
Y (in)

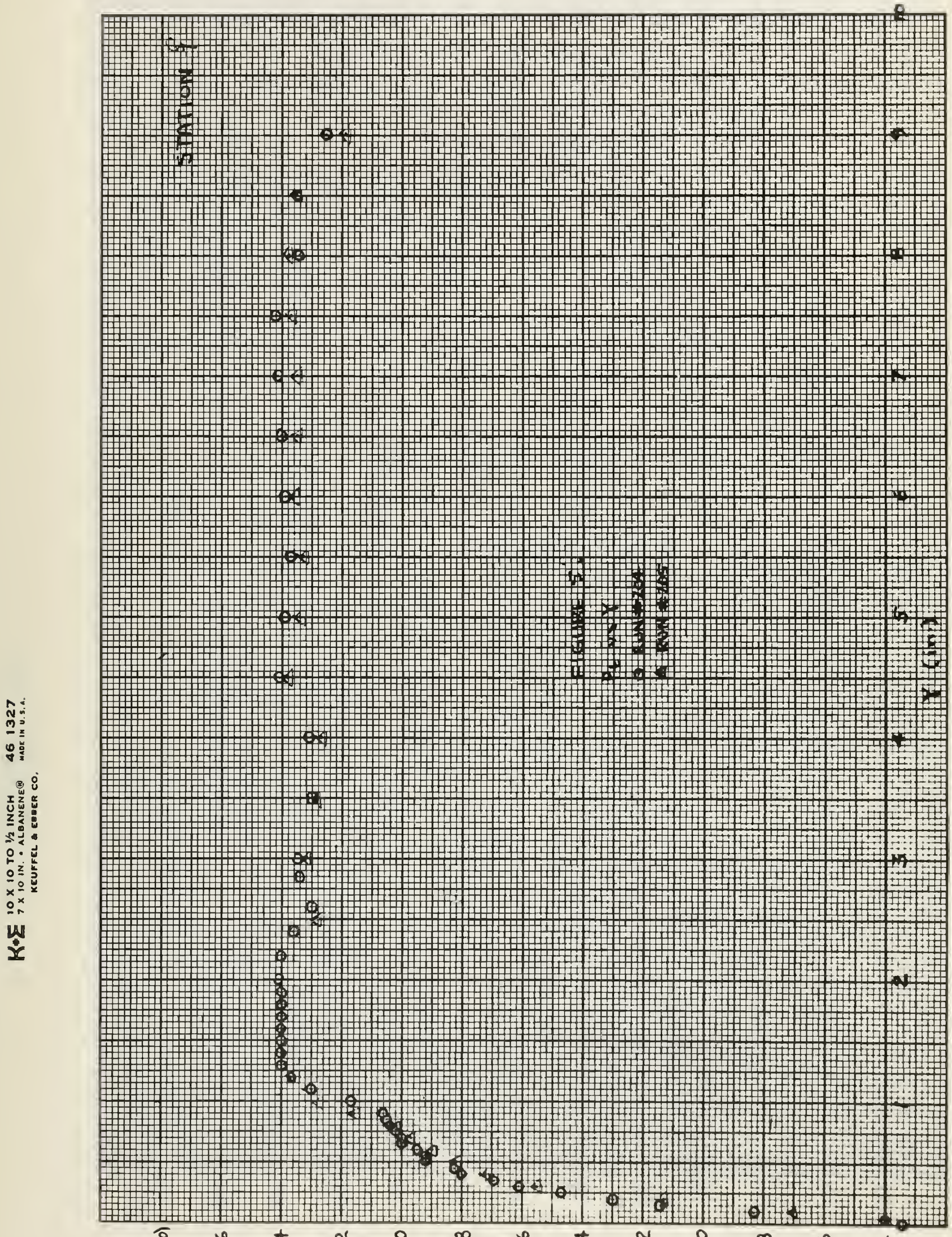


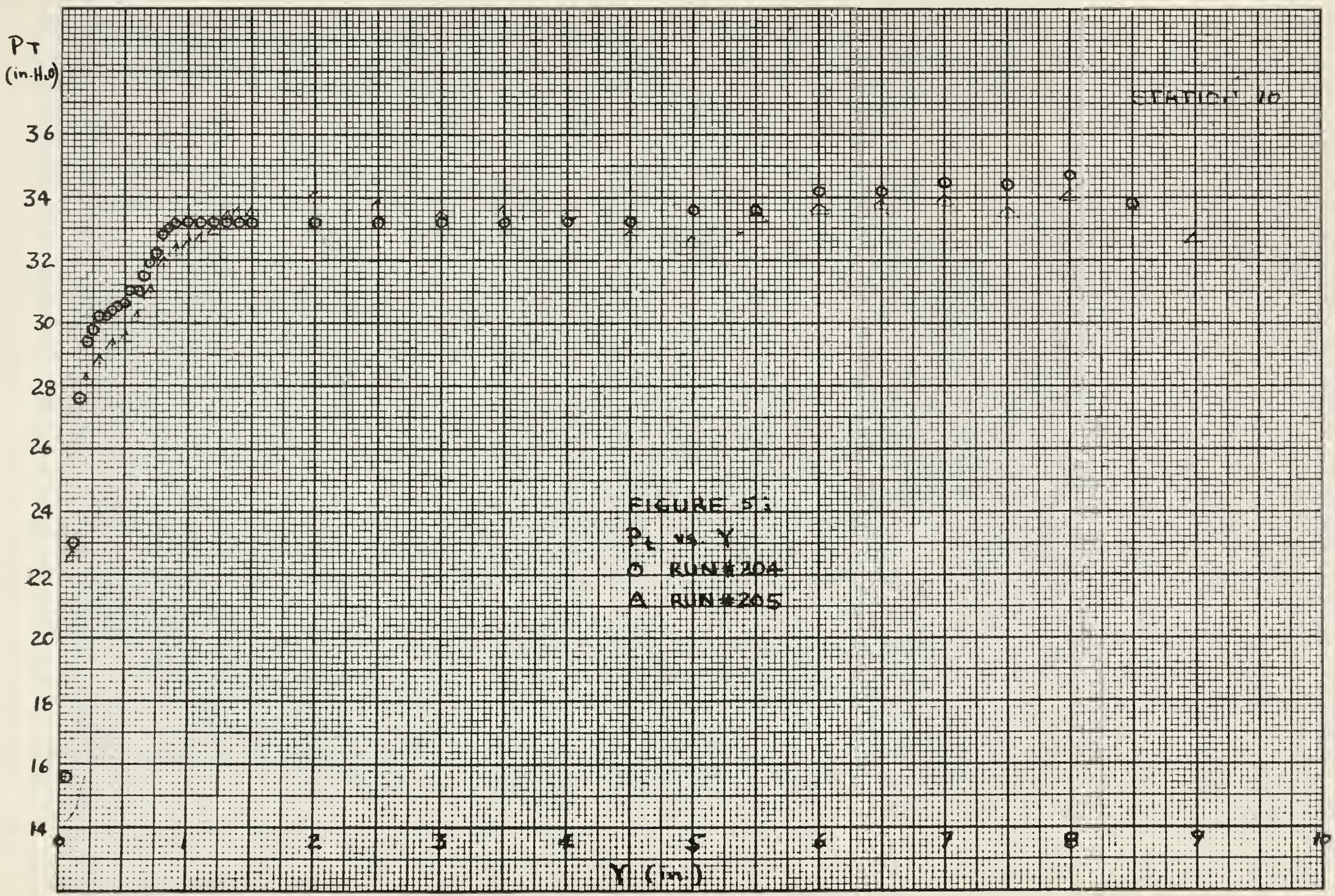
P_T (in. H₂O)
36
34
32
30
28
26
24
22
20
18
16
14
1
2
3
4
5
6
7
8
9
10



STATION 7
FIGURE 5
P vs Y
RUN #204
RUN #205
P_T (in. H_2O)
36
34
32
30
28
26
24
22
20
18
16
14
Y (in)
1
2
3
4
5
6
7
8
9
10


K+E 10 X 10 TO 1/2 INCH 46 1327
7 X 10 IN. • ALBANENE® MADE IN U.S.A.
KEUFFEL & ESSER CO.
STATION 8
FIGURE 5h
P_T vs Y
○ RUN # 204
△ RUN # 205
Y (in.)
P_T (in. H2O)
36
34
32
30
28
26
24
22
20
18
16
14
1
2
3
4
5
6
7
8
9
10


K&E 10 X 10 TO ½ INCH 46 1327
7 X 10 IN. • ALBANENE®
KEUFFEL & ESSER CO.
MADE IN U.S.A.
STATION 5
FIGURE 5.
Y (in)
36
34
32
30
28
26
24
22
20
18
16
14


STATION 10
FIGURE 5i
P_t vs. Y
○ RUN #204
△ RUN #205
P_T (in. H_2O)
36
34
32
30
28
26
24
22
20
18
16
14
0
1
2
3
4
5
6
7
8
9
10
Y (in.)

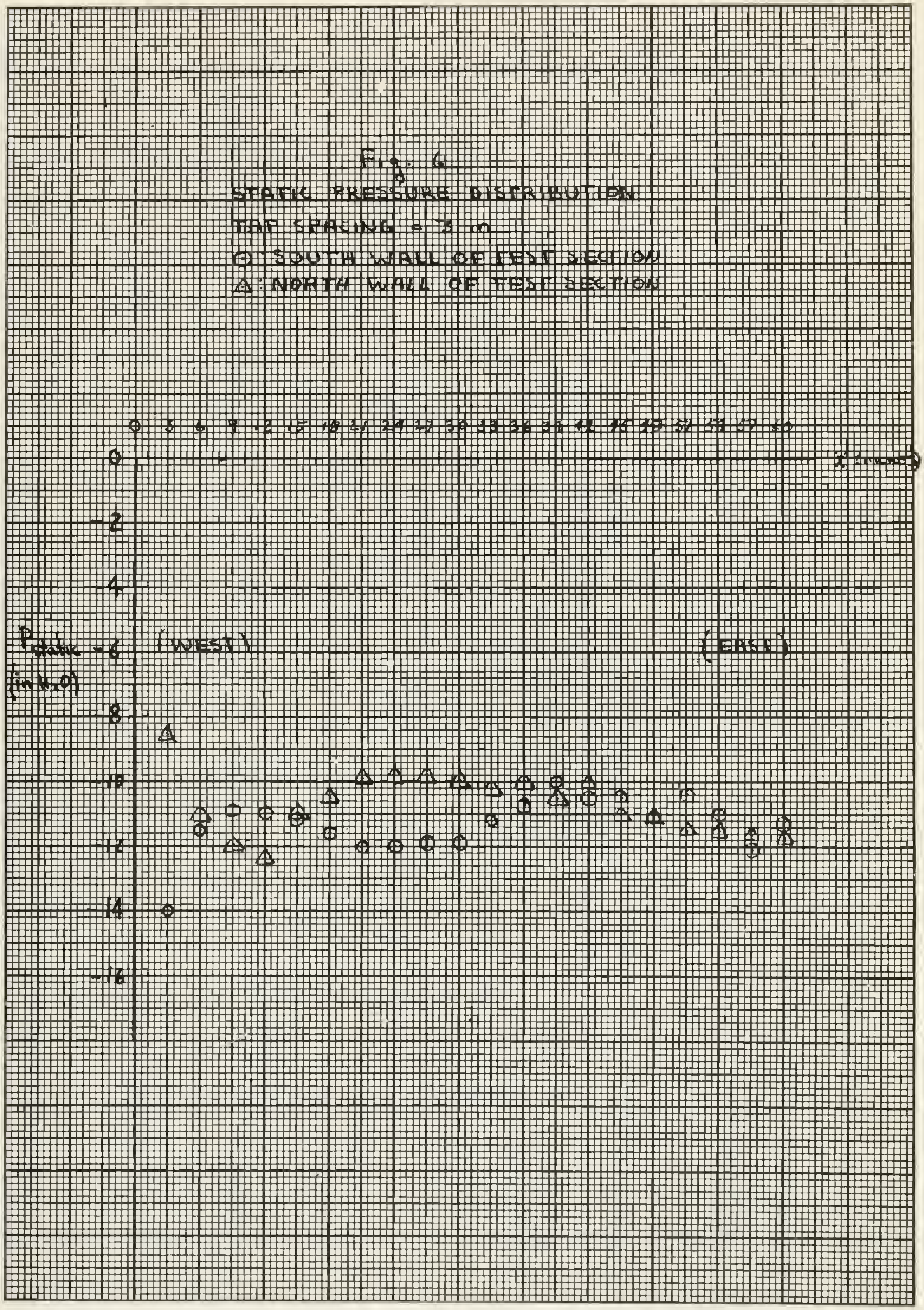


Fig. 6
STATIC PRESSURE DISTRIBUTION
TAP SPACING = 3 in
⊙ : SOUTH WALL OF TEST SECTION
△ : NORTH WALL OF TEST SECTION

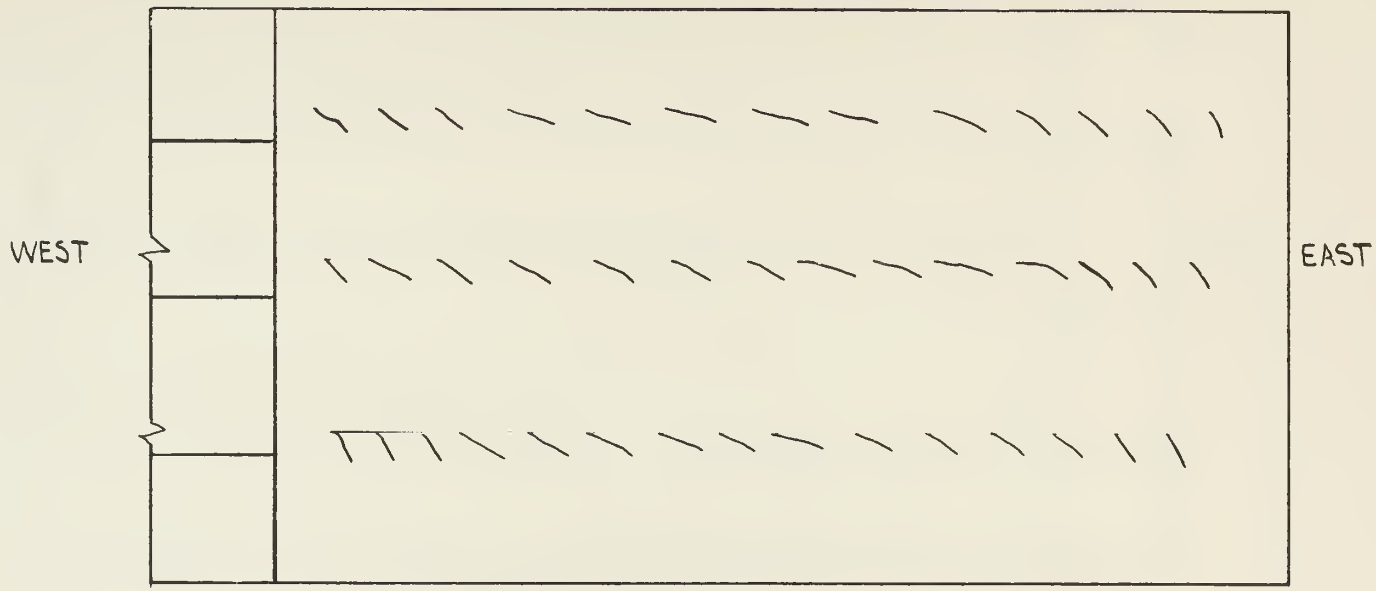


FIGURE 7a

SCHEMATIC OF WOOL TUFT POSITIONS - NORTH WALL OF PLENUM CHAMBER RUN # 204

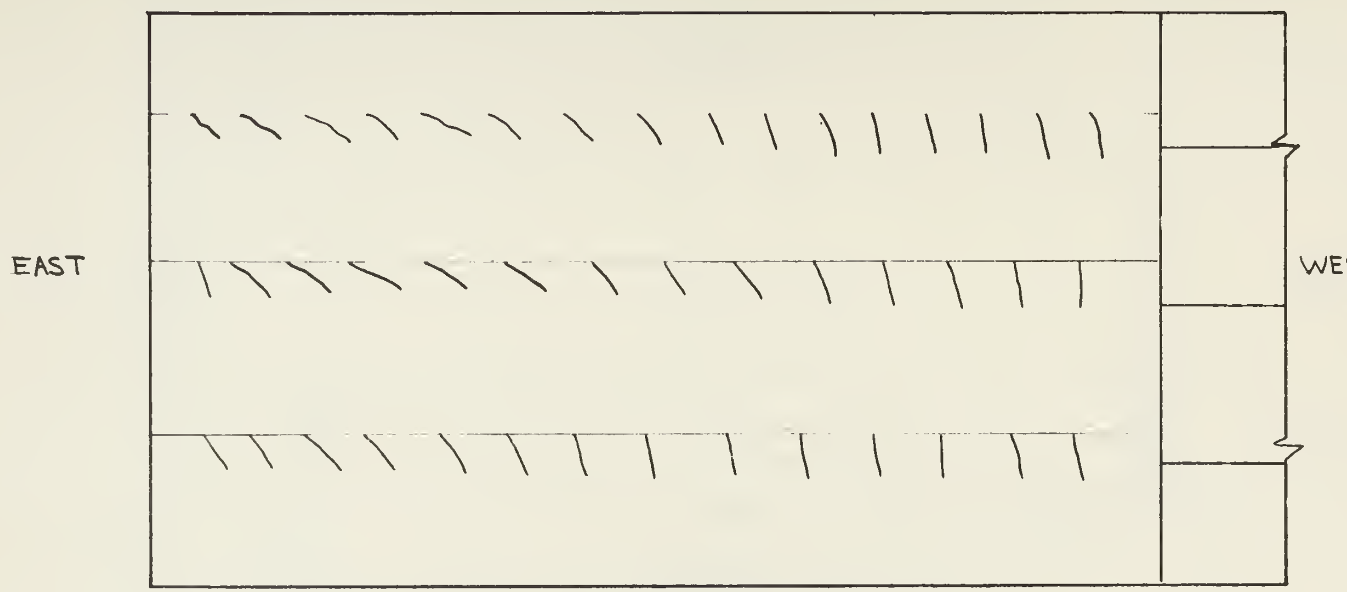


FIGURE 7 b

SCHEMATIC OF WOOL TUFT POSITIONS - SOUTH WALL OF PLENUM CHAMBER RUN # 204

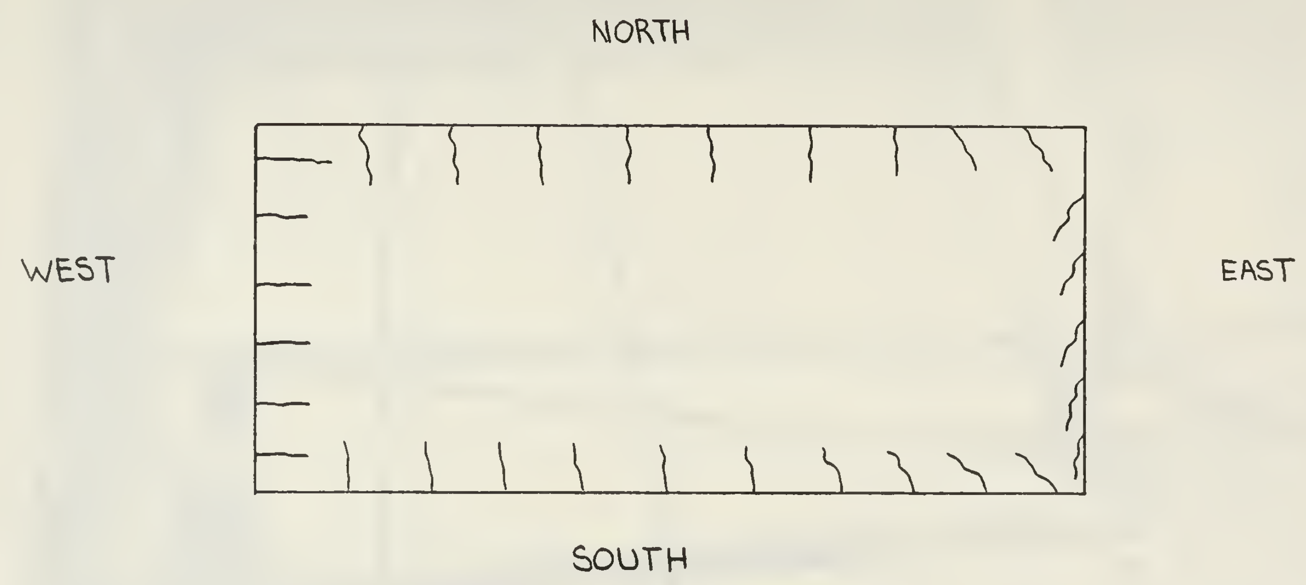


FIGURE 7c

SCHEMATIC OF WOOL TUFT POSITIONS IN THE VICINITY OF THE BELL-MOUTH RUN # 204

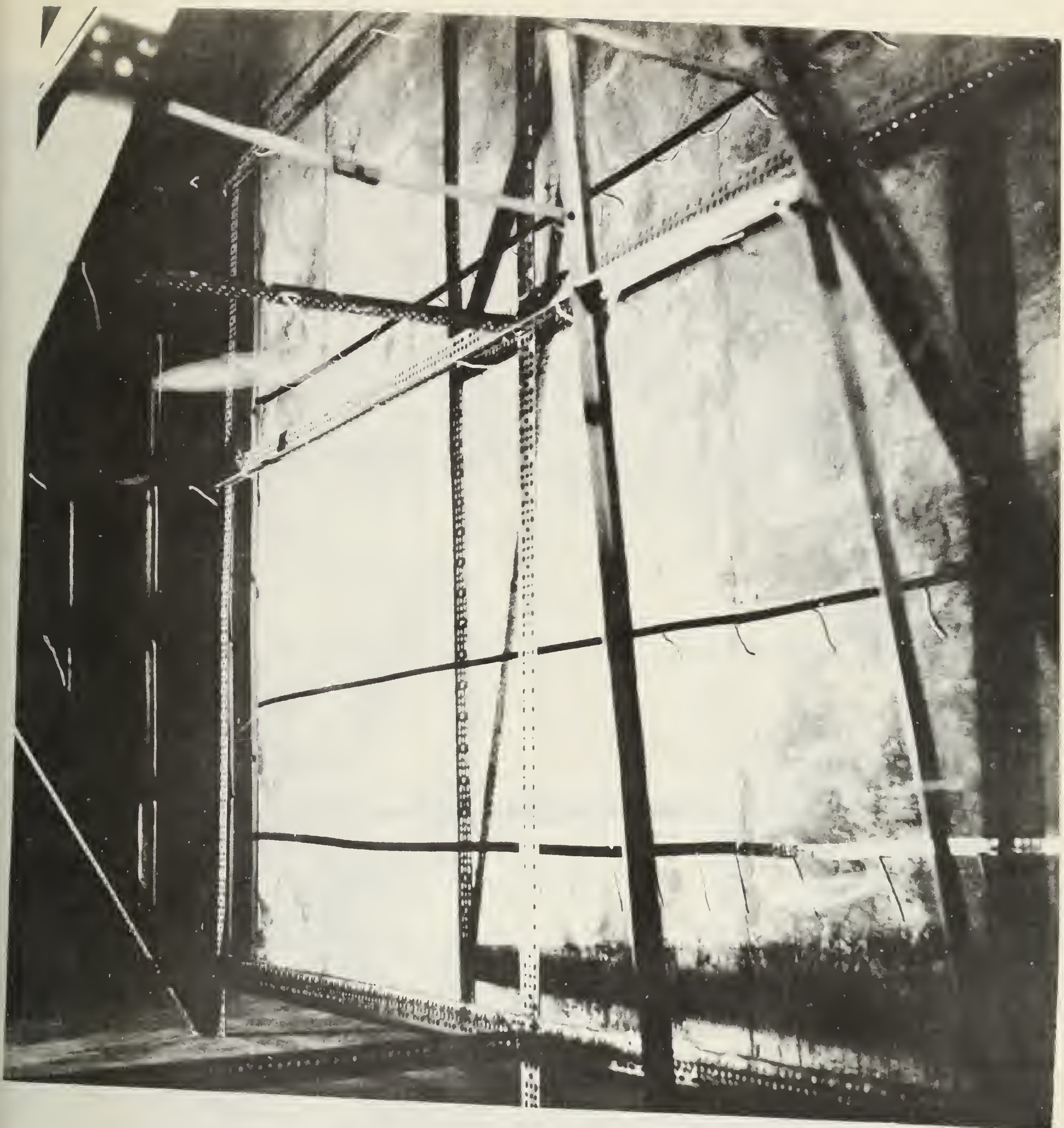


Fig. 8

North wall of plenum chamber

Fig. 9
North wall of plenum chamber, west end (toward sound baffles).

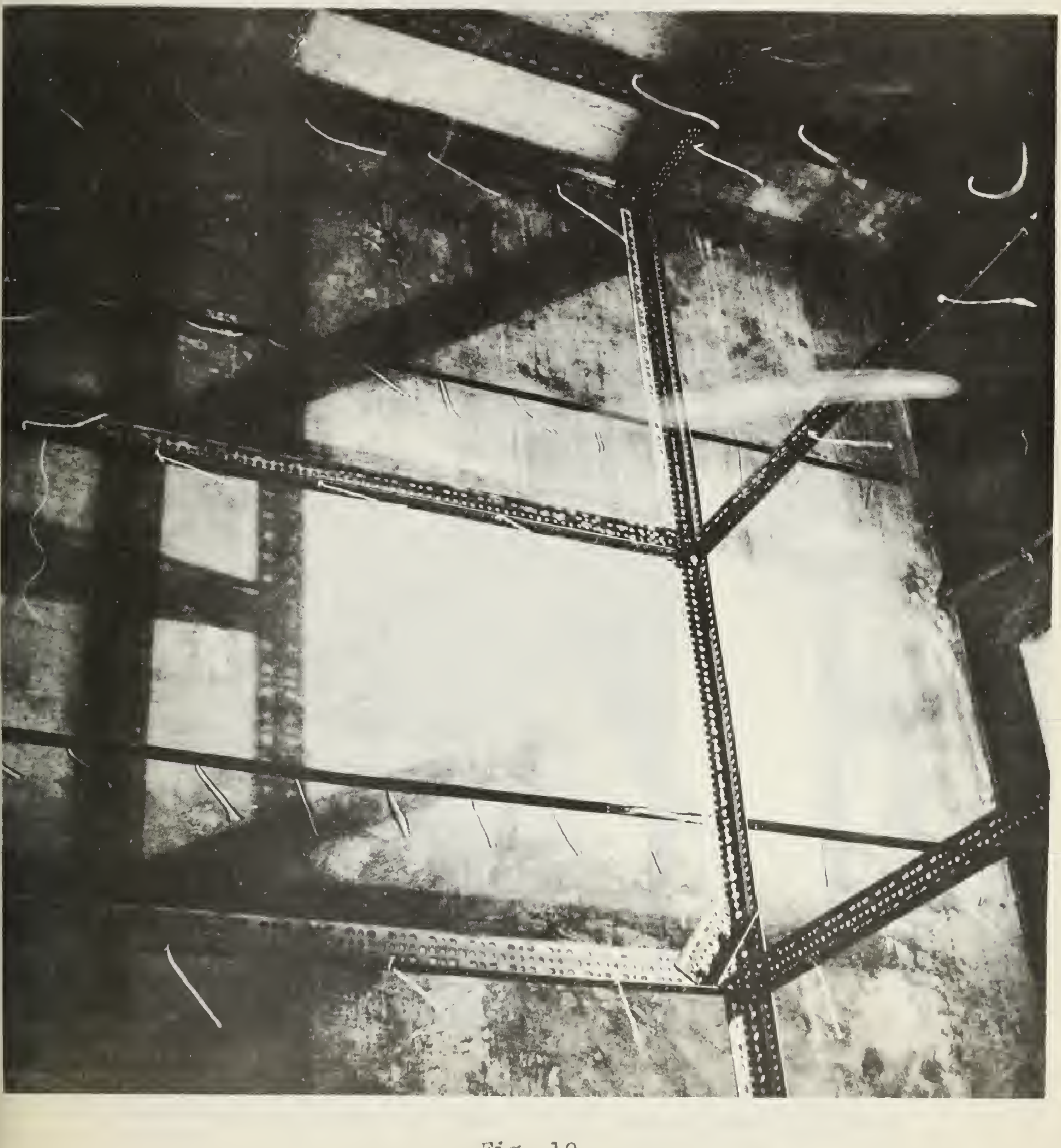


Fig. 10

North wall of plenum chamber, east end.

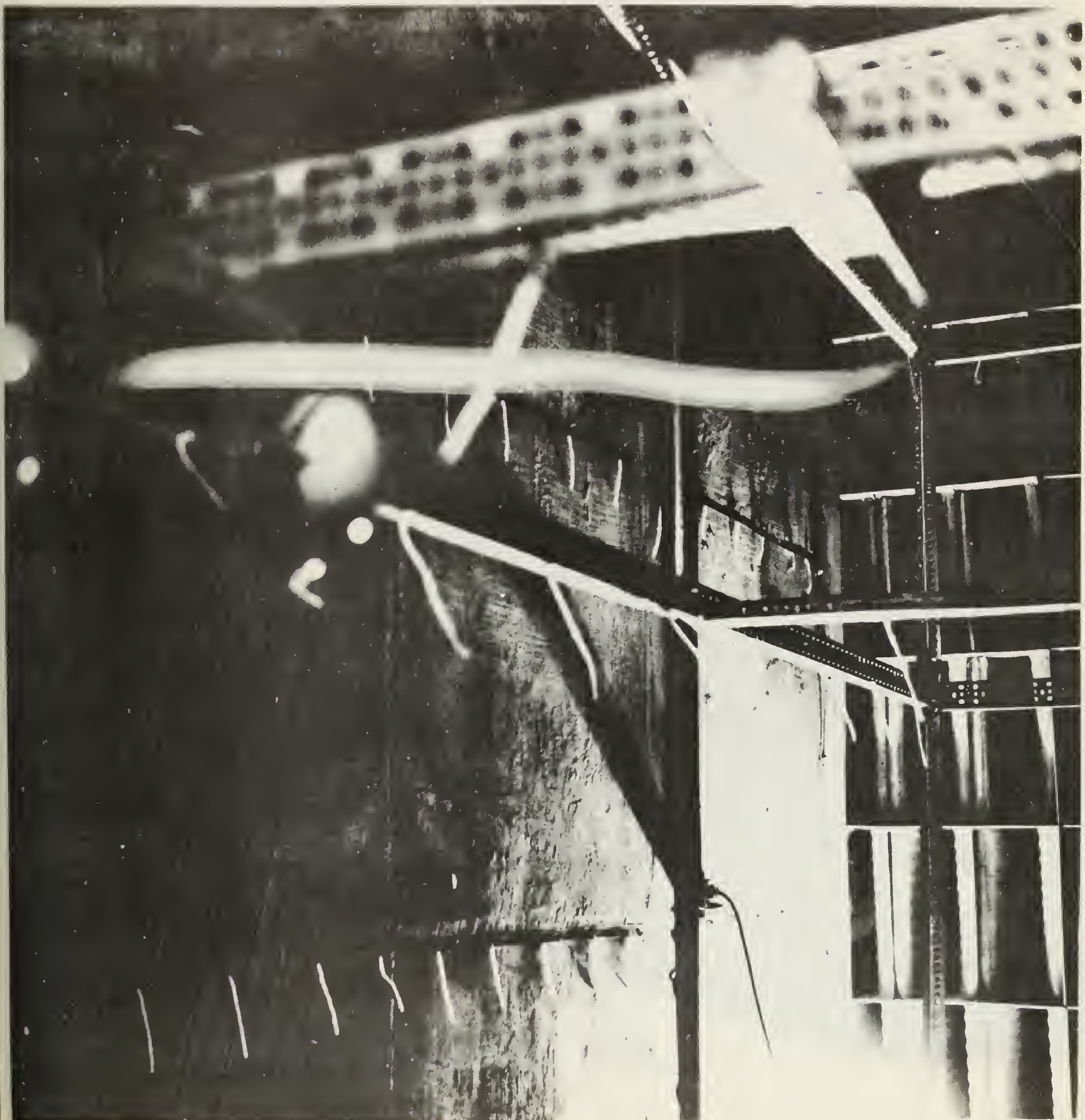


Fig. 11

South wall of plenum chamber, view toward sound baffles (west).

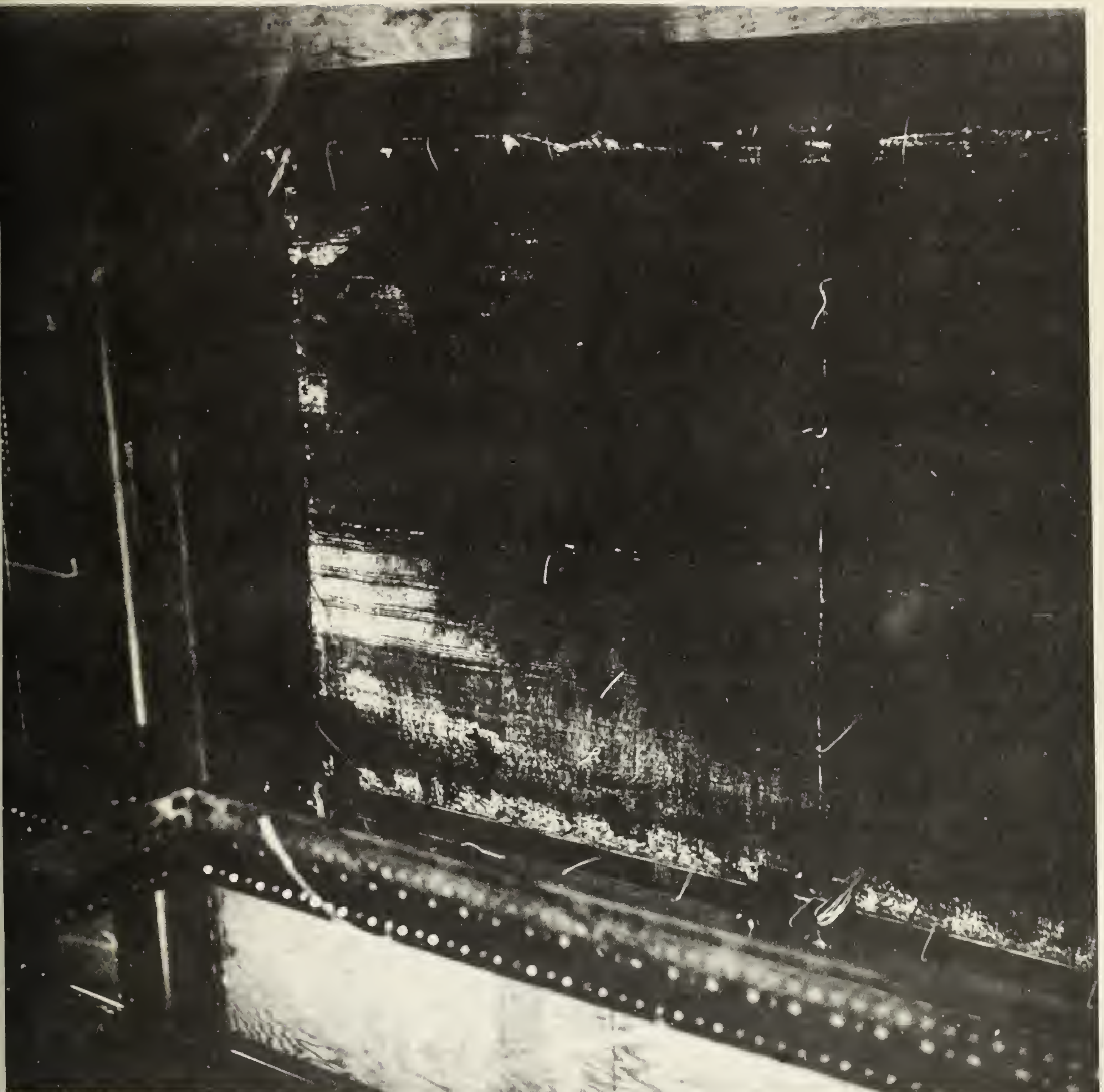


Fig. 12

View of east end of the bell-mouth entrance to the test section (wire mesh screen covers opening). Note wool tufts oriented away from center of inlet.

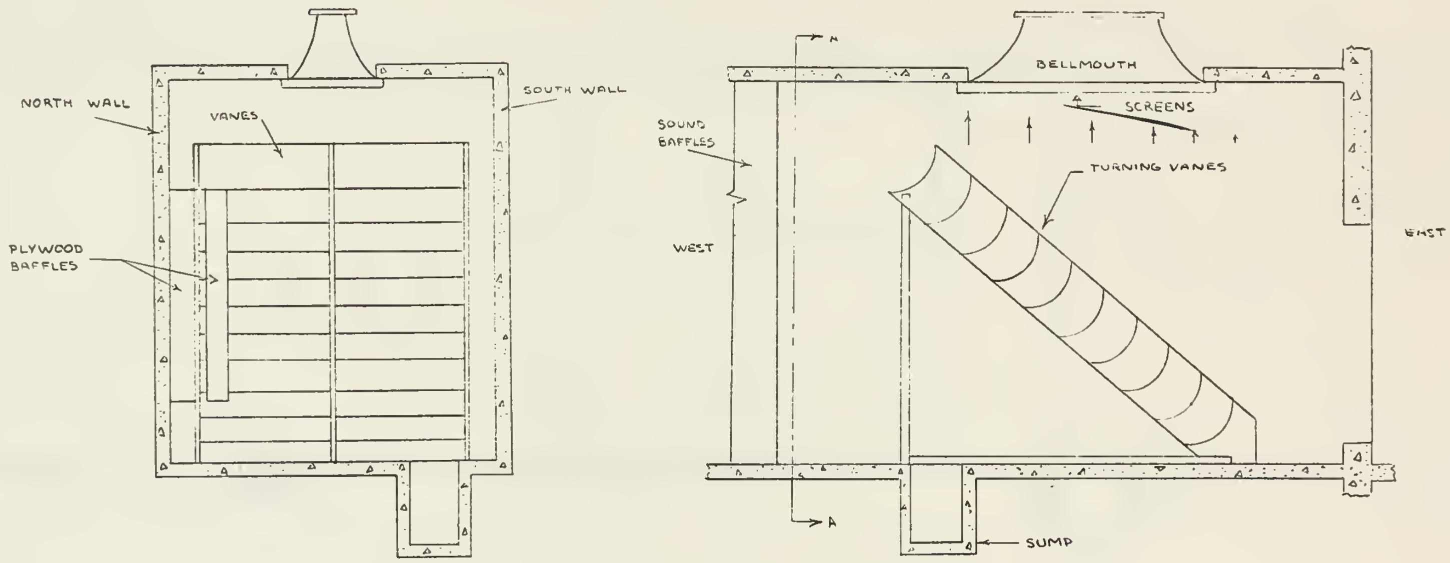


FIGURE 13

PLENUM CHAMBER TURNING VANE
DISCRIPTION

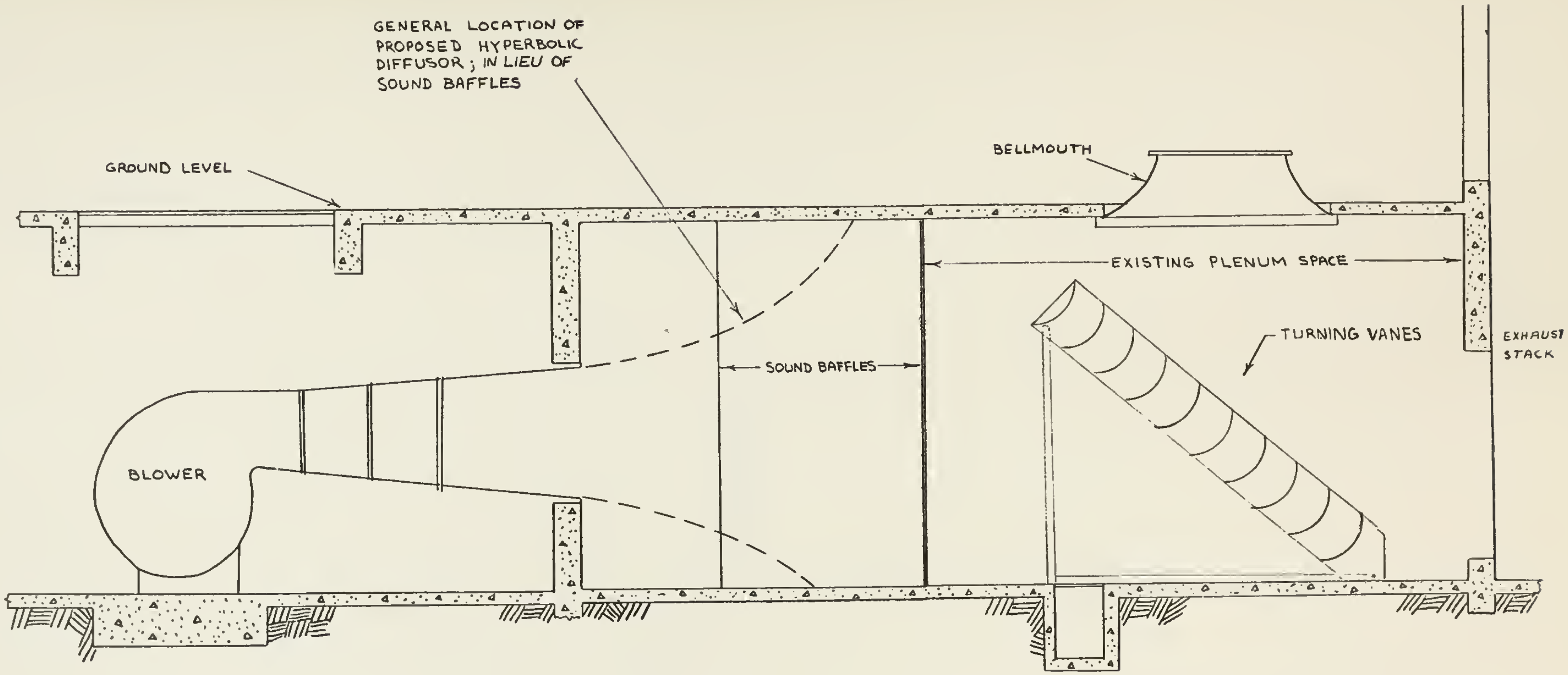


FIGURE 14
CASCADE LABORATORY - BASEMENT
SECTION THROUGH MOTOR/BLOWER
ROOM AND PLENUM CHAMBER

APPENDIX A

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 15 OCT 1965

MANUAL DATA RUN #: 204, TRAVERSE: LOWER ΔP ZERO= ....

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUXUATION IN. H_2O	θ (°)	REMARKS STATION 1
1	0	21.3	—			—	
2	.01	21.3	4.7		±.2	54	
3	.02	21.3	4.8			50	
4	.04	21.3	9.8			50	
5	.05	21.3	11.0			48	
6	.08	21.3	18.0		±1.0	48	
7	.10	21.3	21.5		"	50	
8	.15	21.3	26.6		±.4	50	
9	.20	21.3	29.5			52	
10	.25	21.3	31.8			51	
11	.30	21.3	33.1			56	
12	.35	21.3	34.0			59	
13	.40	21.3	34.4			60	
14	.45	21.3	34.8			60	
15	.50	21.3	34.8			60	
16	.60	21.3	35.0			60	
17	.70	21.3	35.3		STEADY	60	
18	.80	21.35	35.5			60	
19	.90	21.3	35.5			60	
20	1.00	21.3	36.0			56	
21	1.50	21.3	36.0			53	
22	2.00	21.3	35.7			52	
23	2.50	21.3	35.5			52	
24	3.00	21.3	35.8			52	
25	3.50	21.3	35.8			52	
26	4.00	21.3	35.7			52	
27	4.50	21.35	36.2			52	
28	5.00	21.3	36.2			52	
29	5.50	21.3	36.1			58	
30	6.00	21.3	36.2			56	
31	6.50	21.3	35.8			57	
32	7.00	21.3	36.2			58	
33	7.50	21.35	36.0			64	
34	8.00	21.3	36.2			64	
35	8.20	21.35	36.0			64	
36	8.40	21.35	35.4			64	

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 15 OCT 1965

MANUAL DATA RUN #: 204, TRAVERSE: LOWER ΔP ZERO= ....

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUXUATION IN. H_2O	Θ (°)	REMARKS
							STATION 1
37	8.6	21.3	35.0		STEADY	66	
38	8.8	21.3	35.5			56	
39	9.0	21.3	35.9			48	

USNPGS ... RECTILINEAR CASCADE TEST RIG , DATE 15 OCT. 1965

MANUAL DATA RUN # 204 , TRAVERSE: LOWER ΔP ZERO = —

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP IN. H_2O	θ °	REMARKS STATION 2
1	0	21.3	–				
2	.01	21.3	5.1		± .6	50	T_p = 81°F
3	.02	21.3	5.4			50	
4	.03	21.3	5.6			50	
5	.04	21.3	12.0			50	
6	.05	21.3	13.8			47	
7	.06	21.3	16.1		± .8	46	
8	.08	21.3	17.6		± .8	46	
9	.10	21.3	20.2		± .8	46	
10	.15	21.3	24.4		± .8	46	
11	.20	21.3	26.7		± .8	47	
12	.25	21.3	28.2		± .8	46	
13	.30	21.3	28.5		± .6	46	
14	.35	21.3	29.6			46	
15	.40	21.3	30.0		± .2	45	
16	.45	21.3	30.7			48	
17	.50	21.3	31.1		± .2	47	
18	.60	21.3	32.2			48	
19	.70	21.3	32.5			47	
20	.80	21.3	32.0			47	
21	.90	21.3	31.5			48	
22	1.00	21.35	31.7		STEADY	48	
23	1.20	21.3	33.3			50	
24	1.40	21.3	35.2			60	
25	1.60	21.3	35.7			58	
26	1.80	21.3	35.7			57	
27	2.00	21.3	35.7			58	
28	2.50	21.3	35.5			57	
29	3.00	21.3	35.3			55	
30	3.50	21.3	35.3			60	
31	4.0	21.35	35.3			60	
32	4.5	21.3	35.3			60	
33	5.0	21.3	35.1			60	
34	5.5	21.3	35.0			60	
35	6.0	21.3	35.1		± .2	60	
36	6.5	21.25	35.1			58	

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 15 OCT. 1965

MANUAL DATA RUN #: 204, TRAVERSE: LOWER ΔP ZERO= ....

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUXUATION IN. H_2O	Θ (°)	REMARKS STATION 2
37	7.0	21.3	35.0		±.1	63	Pt steady
38	7.5	21.3	35.3			66	
39	8.0	21.3	35.5			65	
40	8.2	21.3	35.6			64	
41	8.4	21.3	35.6			65	
42	8.6	21.3	35.5			65	
43	8.8	21.3	34.5			63	
44	9.0	21.3	32.2		"	60	

USNPGS [illegible] LAB. RECTILINEAR CASCADE TEST RIG, DATE 15 OCT. 1965.

MANUAL DATA RUN #: 204, TRAVERSE: LOWER ΔP ZERO= ....

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUXUATION IN. H_2O	θ (°)	REMARKS STATION 3
1	0	21.3	–		–	–	
2	.01	21.3	4.5		±.8	67	
3	.02	21.3	6.8			67	
4	.03	21.3	10.0			66	
5	.04	21.3	13.2			65	
6	.05	21.3	14.5			64	
7	.06	21.3	16.4			67	
8	.08	21.3	18.0			67	
9	.10	21.3	19.9			64	
10	.15	21.3	24.1			64	
11	.20	21.3	26.0			63	
12	.25	21.3	28.1		±.5	64	
13	.30	21.3	29.3			64	
14	.35	21.3	30.0			61	
15	.40	21.3	30.4			61	
16	.45	21.3	30.6			60	
17	.50	21.3	30.9			60	
18	.55	21.3	31.0			60	
19	.60	21.3	31.4			62	
20	.65	21.3	31.6			62	
21	.70	21.3	32.0			62	
22	.75	21.3	32.4			62	
23	.80	21.3	32.6			62	
24	.85	21.3	32.6			62	
25	.90	21.3	32.6			57	
26	1.00	21.3	32.5			58	
27	1.20	21.3	31.7		±1.0	59	
28	1.40	21.3	31.9		±1.0	64	
29	1.60	21.3	32.7		±1.0	60	
30	1.80	21.3	34.3		±.8	60	
31	2.00	21.3	35.4			58	
32	2.20	21.3	35.3			58	
33	2.40	21.3	35.3		±.6	56	
34	2.60	21.3	35.0		(40)	53	
35	2.80	21.25	35.0			52	
36	3.00	21.3	35.0			53	

USNPGS PROPULSION LAB RECTILINEAR CASCADE TEST RIG, DATE 15 OCT. 1965

MANUAL DATA RUN #: 204, TRAVERSE: LOWER ΔP ZERO = ...

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUXUATIONS IN. H_2O	Θ °	REMARKS
							STATION 3
37	3.5	21.3	35.0		± .1	52	
38	4.0	21.3	34.9			52	
39	4.5	21.3	34.9			52	
40	5.0	21.3	34.8			58	
41	5.5	21.3	34.9			61	
42	6.0	21.3	34.9			61	
43	6.5	21.35	35.0			61	
44	7.0	21.3	35.0			64	
45	7.5	21.3	34.9			65	
46	8.0	21.3	35.3		± .2	65	
47	8.2	21.3	35.3			63	
48	8.4	21.3	35.5			60	
49	8.6	21.3	35.3			60	
50	8.8	21.3	34.4			58	
51	9.0	21.3	32.8			58	

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 15.OCT 1965.

MANUAL DATA RUN #: ..204.., TRAVERSE: LOWER. ΔP ZERO= ....

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUXUATION IN. H_2O	Θ (°)	REMARKS STATION 4
1	0	21.1	-		-	-	
2	.01	21.2	4.8			50	
3	.02	21.3	7.5			50	
4	.03	21.2	8.7			50	
5	.04	21.2	12.7			50	
6	.05	21.3	14.0		±.6	50	
7	.06	21.1	16.3			50	
8	.08	21.2	17.3			50	
9	.10	21.3	19.7			50	
10	.15	21.3	23.2		±.4	50	
11	.20	21.3	25.3		"	50	
12	.25	21.3	27.5		"	50	
13	.30	21.3	29.1		"	50	
14	.35	21.3	30.2		±.5	50	
15	.40	21.3	31.2		±.5	50	
16	.45	21.3	31.8			52	
17	.50	21.3	32.3			54	
18	.60	21.3	32.9			59	
19	.70	21.3	32.8			61	
20	.80	21.3	32.3			62	
21	.90	21.3	31.7		"	66	
22	1.00	21.3	31.4			62	
23	1.20	21.3	31.7			65	
24	1.40	21.3	32.6			60	
25	1.60	21.3	34.0			52	
26	1.80	21.3	34.7			51	
27	2.00	21.3	35.0		±.2	51	
28	2.20	21.3	35.0			51	
29	2.40	21.3	35.0			51	
30	2.60	21.3	35.0			51	
31	2.80	21.25	35.0			51	
32	3.00	21.25	34.9			54	
33	3.50	21.25	34.8			54	
34	4.00	21.3	34.7			54	
35	4.50	21.2	34.5			53	
36	5.00	21.2	34.6			54	

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 15 OCT 1965
MANUAL DATA RUN #: 204, TRAVERSE: LOWER ΔP ZERO= ....

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUXUATION IN. H_2O	Θ (°)	REMARKS STATION 4
37	5.50	21.3	34.7		±.1	54	
38	6.00	21.3	34.7			59	
39	6.50	21.25	33.8			54	
40	7.00	21.25	33.8			54	
41	7.50	21.3	34.5		±.1	55	
42	8.00	21.3	35.1			60	
43	8.20	21.3	35.2			58	
44	8.40	21.3	35.2			60	
45	8.60	21.3	35.2			60	
46	8.80	21.3	34.6		±.1	57	
47	9.00	21.3	32.2			54	

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 15 OCT 1965

MANUAL DATA RUN #: 204, TRAVERSE: LOWER ΔP ZERO = ...

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUXUATION IN. H_2O	Θ (°)	REMARKS STATION 5
1	0	21.0	—	—			
2	.01	21.1	6.6	~~60~~	±1.0	60	
3	.02	21.1	8.6		"	60	
4	.03	21.1	10.3		"	60	
5	.04	21.15	12.5		±1.5	60	
6	.05	21.2	14.0		"	60	
7	.06	21.2	15.5		"	60	
8	.08	21.2	18.0			54	
9	.10	21.2	20.5			54	
10	.15	21.3	24.0		± 2.0	54	
11	.20	21.2	25.8			50	
12	.30	21.2	29.5			52	
13	.40	21.2	30.8			50	
14	.50	21.3	31.5		± .8	60	
15	.60	21.3	32.2			60	
16	.70	21.3	32.2			62	
17	.80	21.2	31.6			60	
18	.90	21.3	31.2			60	
19	1.00	21.2	31.2		± .6	60	
20	1.20	21.2	32.0			62	
21	1.40	21.2	34.0			50	
22	1.60	21.2	34.4			50	
23	1.80	21.2	34.0			70	
24	2.00	21.2	33.5			70	
25	2.20	21.3	33.5			50	
26	2.40	21.3	33.0			50	
27	2.60	21.3	33.9		STEADY	50	
28	2.80	21.3	34.0			50	
29	3.00	21.3	34.0			50	
30	3.50	21.3	34.1			50	
31	4.00	21.3	33.9			50	
32	4.50	21.3	34.2			50	
33	5.00	21.3	34.3			50	
34	5.50	21.3	34.3			50	
35	6.00	21.3	34.3			50	
36	6.50	21.3	34.5			50	

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 15 OCT. 1965

MANUAL DATA RUN #: ...204.., TRAVERSE: LOWER ΔP ZERO= ....

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUCTUATION IN. H_2O	Θ (°)	REMARKS STATION 5
37	7.0	21.3	34.6			50	
38	7.5	21.35	34.8			51	
39	8.0	21.3	35.1		± .2	52	
40	8.2	21.3	35.2			54	
41	8.4	21.3	35.4		"	54	
42	8.6	21.35	35.1			54	
43	8.8	21.35	33.2			52	
44	9.0	21.35	30.1		"	51	

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 15 OCT. 1965.

MANUAL DATA RUN #: 204, TRAVERSE: LOWER ΔP ZERO= ....

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUXUATION IN. H_2O	Θ (°)	REMARKS STATION 6
1	0	20.9	-		-	-	
2	.01	20.9	10.0		±1.0	60	
3	.02	21.0	11.4			60	
4	.03	20.9	13.5		±1.5	60	
5	.04	20.9	15.4			60	
6	.05	20.9	16.4			60	
7	.06	20.95	18.0			60	
8	.07	20.95	18.5			60	
9	.08	20.9	19.4			60	
10	.10	20.9	21.1			60	
11	.12	20.9	22.2			60	
12	.14	20.9	23.6			60	
13	.16	20.9	25.2		±1.0	60	
14	.18	20.9	26.0			60	
15	.20	20.9	26.5			60	
16	.25	20.95	28.0			60	
17	.30	20.9	29.1			60	
18	.35	20.9	29.5			60	
19	.40	20.9	29.9			60	
20	.45	20.9	30.0			60	
21	.50	20.9	30.3			60	
22	.60	20.9	30.7			60	FLUXUATION IN P_T ~±1.0
23	.70	20.9	31.0			60	near WALL.
24	.80	20.95	31.3			60	
25	.90	20.9	31.4			60	
26	1.00	20.9	31.8			60	
27	1.20	20.9	32.9			53	
28	1.40	20.9	33.5		±.80	50	
29	1.60	20.9	33.1			50	
30	1.80	20.9	32.5			50	
31	2.00	20.9	32.2			72	
32	2.20	20.9	32.6			72	
33	2.40	20.9	32.5			72	
34	2.60	20.95	32.2			72	
35	2.80	20.9	32.5		(46)	72	
36	3.00	20.9	33.4		±.4	50	

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USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 15 OCT 1965

MANUAL DATA RUN #: 204, TRAVERSE: LOWER ΔP ZERO= ....

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUCTUATION IN. H_2O	Θ (°)	REMARKS
							STATION 6
37	3.5	20.9	33.5		±.4	50	
38	4.0	20.9	33.0			51	
39	4.5	20.9	32.9		±.2	51	
40	5.0	20.9	33.0			50	
41	5.5	20.9	33.1			52	
42	6.0	20.9	33.7			52	
43	6.5	20.9	34.0		STEADY	54	
44	7.0	21.0	34.0			54	
45	7.5	21.0	33.9			51	
46	8.0	21.0	34.2			52	
47	8.2	21.0	34.5			52	
48	8.4	21.0	34.2			51	
49	8.6	21.0	33.8			50	
50	8.8	21.0	32.3			50	
51	9.0	21.0	30.0		±.2	50	

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 15 OCT 1965.
MANUAL DATA RUN #: 204, TRAVERSE: LOWER ΔP ZERO= ....

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUXUATION IN. H_2O	θ (°)	REMARKS
							STATION 7
1	0	21.0	-	-	.		
2	.01	21.0	9.3		±1.0	74	
3	.02	21.0	11.1			74	
4	.03	21.0	12.1			74	
5	.04	21.0	14.2			74	
6	.05	21.0	15.5			76	
7	.06	21.0	17.0		±1.2	77	
8	.08	21.0	18.1			76	
9	.10	21.0	19.7			72	
10	.15	21.0	24.0			73	
11	.20	21.0	26.3			73	
12	.25	21.0	28.6			73	
13	.30	21.0	28.8			73	
14	.35	21.0	29.2			73	
15	40	21.0	29.3		±1.0	70	
16	45	21.0	30.1			53	
17	.50	21.0	30.7			54	
18	.55	21.0	31.0			60	
19	.60	21.0	31.3			58	
20	.65	21.0	31.3			59	
21	.70	21.0	31.3			62	
22	.75	21.0	31.3			70	
23	.80	21.0	31.0			68	
24	.85	21.0	30.8			70	
25	.90	21.0	30.5			70	Fluxuations of Pt ±1.0
26	1.00	21.0	30.3			61	in.H2O with 1.5 in. of the
27	1.20	21.0	30.3			58	wall.
28	140	21.0	31.7		±.8	50	
29	1.60	20.9	33.1			50	
30	1.80	20.9	33.5			50	
31	2.00	20.9	33.5		±.4	50	
32	2.50	20.9	33.5			50	
33	3.00	20.9	33.1			50	
34	3.50	20.9	33.0		±.2	50	
35	4.00	20.9	32.0			50	
36	4.50	20.9	32.5			52	

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 15.OCT.1965

MANUAL DATA RUN #: 204, TRAVERSE: LOWER ΔP ZERO=

Pt#	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUXUATION IN. H_2O	Θ (°)	REMARKS STATION 7
37	5.0	20.9	33.1		I.2	50	Pt fairly steady
38	5.5	21.0	33.0			50	
39	6.0	21.0	32.8			50	
40	6.5	20.9	33.4			50	
41	7.0	20.9	33.1		"	50	
42	7.5	20.95	33.6			50	
43	8.0	21.0	34.0			50	
44	8.5	21.0	33.6			50	
45	9.0	21.0	31.0			70	

Va. 6/11/65

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 15 OCT. 1965.

MANUAL DATA RUN #: 204 ...., TRAVERSE: LOWER .. ΔP ZERO = ...

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUX UNCERTAINTY IN. H_2O	θ (°)	REMARKS
							STATION 8
1	0	21.0	–				
2	.01	21.0	10.8		± 1.0	74	
3	.02	21.0	13.2			72	
4	.03	21.0	14.3			72	
5	.04	21.0	17.1			70	
6	.05	21.0	18.3			70	
7	.06	21.0	20.8			71	
8	.08	21.0	22.8		"	71	
9	.10	21.0	24.7			70	
10	.15	21.0	28.9			70	
11	.20	21.0	30.1			70	
12	.25	21.0	30.8			70	
13	.30	21.0	30.8			66	
14	.35	21.0	31.0			63	
15	.40	21.0	31.3			64	
16	.45	21.0	31.7			62	
17	.50	21.0	31.9			64	
18	.60	21.0	32.2		± 1.0	65	
19	.65	21.0	32.2			64	
20	.70	21.0	32.1			64	
21	.75	21.0	31.9			64	
22	.80	21.0	31.8			64	
23	.85	21.0	31.7			64	
24	.90	21.0	31.5		± .8	64	
25	.95	21.0	31.5			64	
26	1.00	21.0	31.5			64	
27	1.20	21.0	31.9			62	
28	1.30	21.0	32.5		± .4	72	
29	1.40	21.0	33.1			72	
30	1.50	21.0	33.8			76	
31	1.60	21.0	33.9			76	
32	1.70	21.0	33.8			76	
33	1.80	21.0	33.7			76	
34	1.90	21.0	33.7			76	
35	2.00	21.0	33.6		± .4	76	
36	2.60	21.0	33.2			76	

PAGE .... OF ......

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 15 OCT. 1965
MANUAL DATA RUN #: 204, TRAVERSE: LOWER ΔP ZERO = ...

Pt #	X in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUXUATION IN. H_2O	Θ (°)	REMARKS STATION 8
37	3.0	21.0	33.3		±.2	58	
38	3.5	21.0	33.4			57	
39	4.0	21.0	33.3			56	
40	4.5	21.0	33.3		±.1	56	
41	5.0	21.0	33.3			57	
42	5.5	21.0	33.7		"	57	
43	6.0	21.0	33.9			60	
44	6.5	21.0	34.0			60	
45	7.0	21.0	34.0			60	
46	7.5	21.0	34.0			55	
47	8.0	21.0	34.6		"	55	
48	8.5	21.0	34.3			56	
49	8.6	21.0	33.9			56	
50	8.7	21.0	32.7			56	
51	8.8	21.0	31.5			56	
52	8.9	21.0	31.0			70	
53	9.0	21.0	30.3		±.4	71	

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 15 OCT 1965.
MANUAL DATA RUN #: 204, TRAVERSE: LOWER. ΔP ZERO = ...

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAY.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUXUATION IN. H_2O	θ (°)	REMARKS STATION 9
1	0						
2	.05	21.0	14.0		±1.1	72	
3	.10	21.0	18.3		±1.0	73	
4	.15	21.0	21.4			73	
5	.20	21.0	23.0			73	
6	.25	21.0	24.7			73	
7	.30	21.0	26.1		±1.0	73	
8	.35	21.0	26.9			73	
9	.40	21.0	28.0		±1.0	75	
10	.45	21.0	28.2			74	
11	.50	21.0	29.2			75	
12	.55	21.0	29.2			72	
13	.60	21.0	29.5		±1.0	73	
14	.65	21.0	30.0			73	
15	.70	21.0	30.0		±.8	72	
16	.75	21.0	30.2			70	
17	.80	21.0	30.4			70	
18	.85	21.0	30.5			72	
19	.90	21.0	30.6			70	
20	1.00	21.0	31.7		±.4	74	
21	1.10	21.0	33.0			75	
22	1.20	21.0	33.7			75	
23	1.30	21.0	34.0			75	
24	1.40	21.0	34.0		STEADY	76	Pt indication
25	1.50	21.0	34.0		"	76	steadied out
26	1.60	21.0	34.0			76	
27	1.70	21.0	34.0			76	
28	1.80	21.0	34.0			76	
29	1.90	21.0	34.0			76	
30	2.00	21.0	34.1		"	76	
31	2.20	21.0	34.0			76	
32	2.40	21.0	33.6			76	
33	2.60	21.0	33.0		"	58	Flow angle shift
34	2.80	21.0	33.4			55	
35	3.00	21.0	33.5			56	
36	3.50	21.0	33.0			55	

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 15 OCT. 1965

MANUAL DATA RUN #: 204, TRAVERSE: LOWER ΔP ZERO= ....

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUCTUATION IN. H_2O	Θ (°)	REMARKS STATION 9
37	4.0	21.0	33.1		STEADY	55	
38	4.5	21.0	34.1		"	55	
39	5.0	21.0	33.9			60	
40	5.5	21.0	33.7			60	
41	6.0	21.1	33.9		"	60	
42	6.5	21.1	34.0			60	
43	7.0	21.05	34.1		± .4	60	
44	7.5	21.0	34.2		"	60	
45	8.0	21.0	33.4		"	60	
46	8.5	21.0	33.5		"	58	
47	9.0	21.0	32.5		"	58	

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 15 OCT 1965

MANUAL DATA RUN #: 204...., TRAVERSE: LOWER.. ΔP ZERO= ....

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	$\Delta P_{tot.}$ FLUXUATION IN. H_2O	θ (°)	REMARKS STATION 10
1	0	20.9	0			–	
2	.05	21.3	15.6		±1.0	60	
3	.10	21.3	23.6			60	
4	.15	21.3	27.6			60	
5	.20	21.3	29.4			58	
6	.25	21.2	29.8			58	
7	.30	21.2	30.2			55	
8	.35	21.2	30.2			55	
9	.40	21.2	30.4			55	
10	.45	21.2	30.5			56	
11	.50	21.2	30.6		±1.0	56	
12	.55	21.2	31.0			56	
13	.60	21.2	31.0			56	
14	.65	21.2	31.5			57	
15	.70	21.2	31.9			59	
16	.75	21.2	32.2			60	
17	.80	21.2	32.8			60	
18	.85	21.2	33.0			60	
19	.90	21.2	33.2			60	
20	1.00	21.2	33.2		± 1.0	60	
21	1.10	21.2	33.2			58	
22	1.20	21.2	33.2			58	
23	1.30	21.2	33.2			58	
24	1.40	21.2	33.2		±0.8	57	
25	1.50	21.2	33.2		±0.8	57	
26	2.00	21.2	33.2		±0.4	57	
27	2.50	21.2	33.2			55	
28	3.00	21.2	33.2			55	
29	3.50	21.2	33.2		± 0.4	55	
30	4.00	21.0	33.2			55	
31	4.50	21.0	33.3			55	
32	5.00	21.0	33.6			55	
33	5.50	21.0	33.6			55	
34	6.00	21.0	34.2		± 0.2	58	
35	6.50	21.0	34.2			58	
36	7.00	21.1	34.5			58	

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 15 OCT 1965

MANUAL DATA RUN #: 204, TRAVERSE: LOWER ΔP ZERO= ......

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUXUATION IN. H_2O	θ (°)	REMARKS STATION 10
37	7.5	21.1	34.4		± 0.2	58	
38	8.0	21.1	34.7			59	
39	8.5	21.1	33.8			59	

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RECTILINEAR CASCADE TEST RIG, DATE 9 JAN 1966.

MANUAL DATA, RUN 205, TRAVERSE: LOWER ΔP ZERO= ....

Pt #	X in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUCTUATION IN. H_2O	θ (°)	REMARKS STATION 5
1	0	20.8	-		-	-	
2	.1	20.8	19.5		±.5	53	
3	.2	20.8	25.3		±.4	52	
4	.3	20.8	28.0		±.5	54	
5	.4	20.8	30.1		±.1	56	
6	.5	20.8	30.9		"	56	
7	.6	20.8	31.6		"	60	
8	.7	20.8	31.6		"	62	
9	.8	20.8	31.5		±.2	62	
10	.9	20.8	31.4		"	63	
11	1.0	20.8	31.2		"	62	
12	1.1	20.8	31.3		"	60	
13	1.2	20.8	31.8		±.1	59	
14	1.3	20.8	32.5		"	54	
15	1.4	20.8	33.0		"	50	
16	1.5	20.8	33.3		"	50	
17	2.0	20.8	31.8		"	50	
18	2.5	20.8	32.8		"	47	
19	3.0	20.8	33.1		"	49	
20	3.5	20.75	32.8		"	50	
21	4.0	20.8	32.6		"	50	
22	4.5	20.8	33.2		"	50	
23	5.0	20.8	33.2		"	49	
24	5.5	20.8	33.3		"	50	
25	6.0	20.8	33.6		"	51	
26	6.5	20.8	33.7		"	53	
27	7.0	20.8	33.9		"	53	
28	7.5	20.8	33.8		"	53	
29	8.0	20.8	34.0		"	53	
30	8.5	20.8	34.2		"	53	
31	9.0	20.8	29.5		"	70	

PAGE ... OF ...

... TEST RIG, DATE 9JAN 1966

MANUAL ... 205 ... LOWER ... ΔP ZERO = ...

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAY	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUCTUATION IN H_2O	Θ °	REMARKS
							STATION 6
1	0	20.85	–		–	–	
2	.1	20.85	20.0		±.5	61	
3	.2	20.85	25.0		±1.0	60	
4	.3	20.85	27.7		±1.0	56	
5	.4	20.85	29.4		±.4	56	
6	.5	20.85	30.0		"	56	
7	.6	20.85	30.6		"	58	
8	.7	20.85	31.3		±.2	58	
9	.8	20.85	31.6		"	60	
10	.9	20.85	31.9		"	62	
11	1.0	20.85	31.8		±.3	62	
12	1.1	20.85	31.8		±.2	58	
13	1.2	20.85	32.0		±.3	50	
14	1.3	20.85	32.8		±.2	50	
15	1.4	20.85	32.8		"	50	
16	1.5	20.85	32.8		"	50	
17	2.0	20.85	32.6		"	70	
18	2.5	20.85	32.9		"	70	
19	3.0	20.85	33.2		±.1	50	
20	3.5	20.85	32.9		"	50	
21	4.0	20.85	32.4		"	50	
22	4.5	20.85	31.9		"	50	
23	5.0	20.85	32.1		"	48	
24	5.5	20.85	32.7		"	49	
25	6.0	20.85	33.4		"	51	
26	6.5	20.85	33.6		"	51	
27	7.0	20.85	33.7		"	50	
28	7.5	20.85	33.2		"	50	
29	8.0	20.85	33.8		"	50	
30	8.5	20.85	33.0		"	70	
31	9.0	20.85	29.5		"	70	

PAGE ... OF .....

[illegible] RECTILINEAR CASCADE TEST RIG, DATE 9 JAN 1966

MANUAL DATA RUN #: 205, TRAVERSE: LOWER ΔP ZERO = ...

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUXUATION IN. H_2O	Θ (°)	REMARKS
							STATION 7
1	0	20.8	0			–	
2	.10	20.8	17.4			66	
3	.20	20.8	24.0		±.8	70	
4	.30	20.8	28.2		±.5	70	
5	.40	20.8	29.0		±.8	70	
6	.50	20.8	29.5		±.4	70	
7	.60	20.8	30.6		±.2	60	
8	.70	20.8	30.8		"	62	
9	.80	20.8	30.7		"	64	
10	.90	20.8	30.1		±.4	64	
11	1.00	20.8	30.0		"	64	
12	1.1	20.8	30.4		"	68	
13	1.2	20.8	31.0		±.2	54	
14	1.3	20.8	32.2		"	52	
15	1.4	20.8	33.0		"	52	
16	1.5	20.8	33.6		±.2	51	
17	2.0	20.8	33.4		±1	49	
18	2.5	20.8	32.6		"	49	
19	3.0	20.8	32.5		"	50	
20	3.5	20.8	32.5		"	50	
21	4.0	20.8	32.2		"	48	
22	4.5	20.8	32.0		"	50	
23	5.0	20.8	32.8		"	50	
24	5.5	20.8	32.6		"	50	
25	6.0	20.8	32.9		"	50	
26	6.5	20.8	33.2		"	50	
27	7.0	20.8	32.7		"	50	
28	7.5	20.85	33.5		"	50	
29	8.0	20.8	33.8		"	50	
30	8.5	20.8	33.0		"	50	
31	9.0	20.8	30.9		±.2	50	

PAGE .... OF .....

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 9. JAN. 1966

MANUAL DATA RUN #: 205...., TRAVERSE: LOWER.. ΔP ZERO= ....

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUCTUATION IN. H_2O	θ (°)	REMARKS STATION 8
1	0	20.8	–		-	–	
2	.1	20.8	23.7		±.4	60	
3	.2	20.8	29.6		"	60	
4	.3	20.8	30.5		±.4	60	
5	.4	20.8	31.1		±.2	52	
6	.5	20.8	31.5		"	52	
7	.6	20.8	31.8		"	50	
8	.7	20.8	31.6		"	58	
9	.8	20.8	31.3		"	59	
10	.9	20.8	31.0		"	59	
11	1.0	20.8	31.1		"	55	
12	1.1	20.8	31.3		"	53	
13	1.2	20.8	31.6		"	50	
14	1.3	20.8	31.8		"	50	
15	1.4	20.8	33.0		"	61	
16	1.5	20.8	33.7		"	64	
17	2.0	20.8	33.9		"	68	
18	2.5	20.8	33.5		"	69	
19	3.0	20.8	32.5		"	60	
20	3.5	20.8	32.7		"	52	
21	4.0	20.8	32.7		"	50	
22	4.5	20.8	32.6		"	51	
23	5.0	20.8	32.7		"	50	
24	5.5	20.8	33.1		"	53	
25	6.0	20.8	33.5		±.1	51	
26	6.5	20.8	33.6		"	50	
27	7.0	20.8	33.6		"	52	
28	7.5	20.8	34.1		"	51	
29	8.0	20.8	34.0		"	50	
30	8.5	20.8	34.0		"	50	
31	9.0	20.8	31.4		"	70	

PAGE .... OF .....

USNPGS PROPULSION LAB. RECTILINEAR CASCADE TEST RIG, DATE 9 JAN 1966.

MANUAL DATA RUN #: 205...., TRAVERSE: LOWER... ΔP ZERO= ....

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUXUATION IN. H_2O	θ (°)	REMARKS STATION 9
1	0	20.8	-		-	-	
2	.1	20.8	17.0		±.4	60	
3	.2	20.8	21.3		"	65	
4	.3	20.8	25.5		"	70	
5	.4	20.8	27.2		±.5	68	
6	.5	20.8	28.2		"	70	
7	.6	20.8	29.0		±.2	70	
8	.7	20.8	29.7		±.4	70	
9	.8	20.8	30.2		"	70	
10	.9	20.8	31.6		"	70	
11	1.0	20.8	32.8		"	70	
12	1.1	20.8	33.2		"	70	
13	1.2	20.8	33.7		±.5	70	
14	1.3	20.8	33.9		±.2	70	
15	1.4	20.8	34.0		"	70	
16	1.5	20.8	34.0		"	70	
17	2.0	20.8	34.0		"	69	
18	2.5	20.8	32.9		"	70	
19	3.0	20.8	32.7		"	70	
20	3.5	20.8	32.9		"	70	
21	4.0	20.8	32.7		"	49	
22	4.5	20.8	33.8		"	51	
23	5.0	20.8	33.4		"	50	
24	5.5	20.8	33.3		"	50	
25	6.0	20.8	33.6		"	50	
26	6.5	20.8	33.5		"	50	
27	7.0	20.8	33.5		"	50	
28	7.5	20.8	33.7		"	50	
29	8.0	20.8	33.8		"	50	
30	8.5	20.8	33.5		"	50	
31	9.0	20.8	31.9		"	47	

USNPGS PROPULSION LAB RECTILINEAR CASCADE TEST RIG, DATE 9 JAN 1966.
MANUAL DATA RUN #: 205, TRAVERSE: LOWER ΔP ZERO= ....

Pt #	Y in.	P_{PLENUM} IN. 1.75 GRAV.	P_{tot} IN. H_2O	Q IN. H_2O	ΔP_{tot} FLUXUATION IN. H_2O	Θ (°)	REMARKS STATION 10
1	0	20.8	–		–	–	
2	.1	20.8	22.6		±.2	50	
3	.2	20.8	28.2		"	48	
4	.3	20.8	28.7		"	50	
5	.4	20.8	29.3		"	47	
6	.5	20.8	29.5		"	46	
7	.6	20.8	30.2		"	48	
8	.7	20.8	31.0		"	50	
9	.8	20.8	31.9		±.4	50	
10	.9	20.8	32.3		±.2	50	
11	1.0	20.8	32.5		"	50	
12	1.1	20.8	32.7		"	50	
13	1.2	20.8	33.0		"	48	
14	1.3	20.8	33.4		"	49	
15	1.4	20.8	33.6		"	49	
16	1.5	20.8	33.5		"	49	gradual Θ shift between
17	2.0	20.8	34.0		±.1	70	Y=1.5" and Y=2.0"
18	2.5	20.8	33.8		±.2	70	
19	3.0	20.8	33.4		"	70	
20	3.5	20.8	33.6		"	70	
21	4.0	20.8	33.4		"	70	
22	4.5	20.8	32.8		"	70	
23	5.0	20.8	32.6		"	50	
24	5.5	20.8	33.4		"	50	
25	6.0	20.8	33.6		"	50	
26	6.5	20.8	33.8		"	50	
27	7.0	20.8	33.9		"	50	
28	7.5	20.8	33.5		"	50	
29	8.0	20.8	34.1		"	50	
30	8.5	20.8	33.6		"	48	
31	9.0	20.8	32.7		"	70	

Ya 6/11/65